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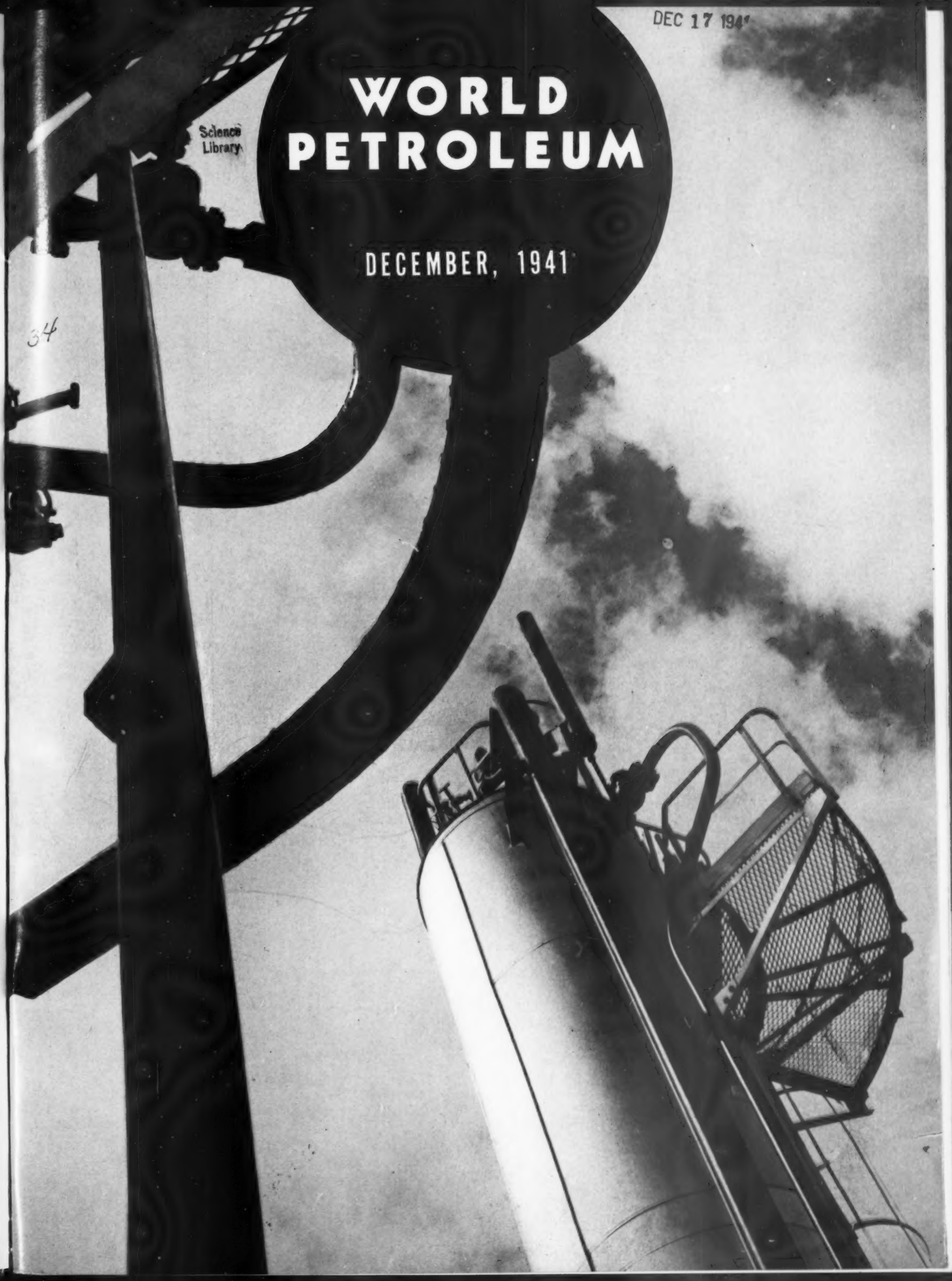

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WORLD PETROLEUM

Founded as Petroleum Equipment Exporter

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Above, one of the cracking towers at the recently completed Lake Charles refinery of the Continental Oil Company; the front cover illustration shows a view of one of the alkylation towers of this plant. Both photographs were taken by Ulric Meisel. An article describing the plant appears on page 36.

EDITORIAL

WASHINGTON'S "SINGULAR" OIL AGREEMENT WITH MEXICO

For three years eight months and one day the State Department of the United States maintained a position in reference to the seizure by the Mexican government of properties belonging to the shareholders of American oil companies that was based on equity, supported by international law and in accord with the traditional attitude of the nation. One day later it abandoned this solid ground and agreed to a valuation of the properties of the despoiled owners without any definition of what these are to include—which has been the main point at issue in past discussions—and without any safeguard of the fundamental rights of the investors except the possibility that the two arbitrators may disagree. These unfortunate owners face the probability of being sold down the river, nominally in the cause of hemispheric solidarity which actually was nowise involved.

Under the circumstances quite the most illuminating passage in the agreement signed by Secretary of State Hull and Mexican Ambassador Najera is the final paragraph. "Nothing in this note shall be regarded as a precedent or be invoked by either of the two governments in the settlement between them of any future difficulty, conflict, controversy or arbitration" reads the statement, "The action herein provided for is considered as singular and exceptional, appropriate solely to this case, and motivated by the character of the problem."

This is strange phraseology for a document drawn by two experienced diplomats who must be well aware that precedents are established by actions, not by words. The disclaimer evidently is intended to cover the abandonment by the United States of the position steadily maintained by the Secretary of State up to this time that expropriation of privately owned property must be accompanied by "adequate, effective and prompt compensation" and that unless so accompanied it becomes confiscation. In everyday language the clauses quoted above may be interpreted as saying in effect "We are letting you get away with a high handed procedure this once owing to exceptional circumstances but don't try it again." The description of the agreement as "singular" is one with which those who have followed the case from the beginning will agree emphatically and the protestation that it is not to be regarded as a precedent is not likely to trouble any future administration in Mexico or elsewhere that feels disposed to seize the properties of American citizens. In such a situation procedure speaks far more loudly than mere phrases.

One of the mysteries of this whole affair is the insistence upon including the appraisal of the seized oil properties in an agreement concerned primarily with the extension of financial support to Mexico. The United States could have made the various loans provided for and could have renewed its subsidy on Mexican silver without reference to the question of the oil properties. The agreement is not a comprehensive settlement of outstanding issues. It does not touch, for example, upon the huge Mexican debt which remains in default nor upon the losses incurred by owners of mines and other industrial enterprises that have been subjected to seizure. The oil companies themselves have indicated their preference to have the oil question omitted from consideration under any arrangement such as the one now adopted. Moreover, it is the conviction of observers who have followed closely the developments in the oil situation that if the State Department had stood firm on the principle which it has clearly stated in past exchanges with Mexico the time would have come, and that in the not distant future, when a fair arbitration or a direct settlement would have been possible. One may be permitted to guess that Mexican anxiety to dispose of the oil question on their own terms at this time may be related to the expectation of a trade agreement that will admit oil from Mexico to United States markets either free of duty or much below the established rate.

It would be unfair to prejudge the attitude and actions of the two representatives to whom is to be intrusted the

difficult task of determining the fair value of the properties concerned. It is reasonable to assume however, that the Mexican representative will uphold the claim previously made by his government that only surface structures are to be considered and that the representative of the United States will face the choice of accepting this thesis or seeing the joint effort end in disagreement. Considering that subsoil holdings, the right to extract oil that has been located below the surface, is the all-important element in oil property values a decision that disregarded it would be farcical yet the oil companies would face the strong probability of having such a decision forced upon them if they were to agree to the procedure now adopted. By withholding agreement they are not compelled to accept the findings of the valuation commission according to the explanation made public by Secretary Hull but paragraph twelve of the agreement itself stipulates that both governments shall regard as unappealable the joint report of the valuation experts and consequently shall accept as definitive the compensation and interest fixed in such report. In other words if the companies do not choose to accept whatever is allotted them they can look for no assistance from their own government and certainly they can expect no consideration from Mexico once the stand of the latter is reenforced by compliance of the United States.

Among the many vague clauses in the agreement is the statement that the appraisers are "not to take into account reasons of a technical nature" and the whole document is expressed in such cloudy terms that the valuation commissioners will find themselves wandering in the realm of unreality if they attempt to follow it as a guide. Under its provisions the oil companies apparently will be restricted to supplying such "pertinent evidence" as may be asked for at the request of the Mexican representative and if they decline to comply with such requests no statement or evidence which they may advance will be considered. Perusal of the agreement as a whole, however it may be interpreted in the sphere of diplomacy, inevitably suggests to the man who looks at language as a medium to reveal rather than conceal thought that the cards have been cleverly stacked against the shareholders of the oil companies in advance.

Aside from the special memorandum relating to the oil property confiscation the agreement just concluded obligates the United States to provide $40,000,000 as a "stabilization fund", to make a loan of $30,000,000 through the Export-Import Bank at the rate of $10,000,000 yearly for road building in Mexico, to consider applications for further loans "for productive purposes" and to purchase 6,000,000 ounces of absolutely useless silver involving an expenditure of $25,000,000 per year. For its part Mexico undertakes to pay to the United States $34,000,000 at the rate of $2,500,000 a year which with past payments of $6,000,000 will make a total of $40,000,000 in settlement of all agrarian and general claims. Apparently no assurance is given by Mexico that it will abstain from further acts of confiscation and no reference is made to the unpaid principal and interest of Mexico's foreign debt amounting to $1,000,000,000. Press reports from Mexico indicate that in certain financial quarters there it is assumed that this obligation is wiped out by the payment of $40,000,000.

The mere statement of the provisions of this remarkable agreement explains why it was hailed with rejoicing in Mexico City as a great diplomatic triumph for the Mexican negotiators. Politically it points to the continued ascendancy of the Cardenas element with its communistic objectives in the Mexican political field and in the cabinet of President Avila Camacho.

It is more difficult to find an adequate explanation for the expectations voiced in some Mexican circles of a great influx of investments from the United States as a result of the agreement between the two governments. In view of the fact that it provides no promise of relief for investors who put their money into oil, mining and manufacturing enterprises that have been arbitrarily seized by Mexican authorities or for those who have purchased bonds of the railways and the government itself and that it contains no assurance that such acts of confiscation will not be repeated whenever it suits the mood of the faction in power it is difficult to see how any responsible organization can expose the funds of its members to further depredations. It may be however that the opinion clearly prevailing among great numbers of Mexicans that the United States Treasury through the Export-Import Bank stands ready to act as fairy godmother in granting any demands they may make holds that this is ample to assure an era of industrial expansion and prosperity. The Mexican attitude is easier to understand than that of the administration in Washington. The suggestion that its action was necessary to assure Mexico's cooperation in a Pan-American international policy is far-fetched as well as being most uncomplimentary to the Mexican people. The record of history shows that good will cannot be bought and that the kind of political support that can be purchased is never dependable.

ALLOCATIONS To Meet Oil Industry Needs

Coordinator's Estimates of Requirements For Expanded Production, Transportation And Refining Activities Appears Assured of SPAB Acceptance.

ALTHOUGH the Petroleum Coordinator's estimate of 5,846,000 tons of iron and steel, as the minimum requirement for the effort expected of the oil industry in 1942, is still pending in the Supply Priorities and Allocations Board, recent priorities orders indicate that this over-all recommendation will have to be approved when the general allocation decision is reached. Immediate action on orders already issued by the Priorities Division of the Office of Production Management, was designed to make possible the speedy manufacture of steel drums for overseas shipments of gasoline, oil and other petroleum products. This followed closely after the OPC had formally urged the industry to discontinue the use of steel containers in domestic distribution. The urgent need of this particular equipment for use abroad explains both steps. While this is a fragmentary part of the whole requirement, the action of OPM sustains the basic soundness of the metal estimate of OPC for 1942, if the industry is not merely to continue production, refining, transportation and distribution operations at the present rate of 500,000 bbl. daily more than last year, but also step them up to a higher level during 1942.

In laying his estimate before SPAB and the priorities division Coordinator Ickes pointed out that under present emergency conditions, only the construction, transportation and machinery industries outrank the oil business in their requirements for steel. With the cooperation of the four operative divisions of the OPC, an analysis of the situation placed the requirements of 1942 for the four divisions of the industry as follows:

Division	Iron and Steel—Tons
Production:	
On basis of more than 30,000 wells	3,175,000
Transportation:	
For pipelines, tank cars, tank trucks	1,843,000
Refining:	
Including aviation gasoline facilities	647,000
Marketing	181,000
TOTAL	5,846,000

Of the largest item, 3,175,000 for production, 1,817,000 tons will be required in tubular goods. Under the allowance of 1,843,000 tons for transportation, provision has been made for an amount of pipe sufficient for construction of the Texas-Eastern seaboard pipeline, not so much in expectation that it will be built, as on the assumption that a comparable amount of steel will be needed for pipeline additions of a different type and for other transportation facilities. In this connection it is pointed out that while there are now 56,000 miles of pipelines which gather the oil of 300,000 wells, these systems will have to be steadily enlarged to take care of new wells and increased production which cannot be moved without new connecting lines from the fields.

In the refining figure of 647,000 tons of iron and steel, the amount required for trebling the facilities for aviation gasoline has been included. This is estimated at about 150,000 tons and is certain of full allocation because of the manifest necessity of expanding the capacity for production of 100-octane gasoline. Although five new plants have received priorities rating for material this month, to bring the total number to 20, either building or to be commenced soon for the production of high-test fuel, authorities in Washington believe that possibly as many as 50 new refining units must be put in operation in the United States to care for military needs of the United States and the lend-lease requirements of Britain and Russia. Latest additions authorized for refinery facilities for high-test gas, by location and type are: Atlantic Refining Company, Philadelphia, Pa., 100-octane; Standard Oil Company of Ohio, Toledo, O., isopentane; Shamrock Oil and Gas Company, Amarillo, Tex., isobutane; Standard Oil Company of California, Richmond, Calif., thermal-cracking unit; Union Oil Company, Los Angeles, Calif., polyform-cracking unit. It is estimated that it will take from nine to 14 months to start producing at the new plants, and it may be difficult to raise the present production of 100-octane gasoline from present output of 40,000 bbl. daily to more than 60,000 bbl. before late next year. The goal of the OPC is 120,000 bbl. daily.

"There is no spigot to be turned on to provide fuel for vastly increased numbers of tanks and planes," said Wright W. Gary, director of the refining division of OPC referring to the $2,500,000,000 tank and aircraft program of the Army.

While there is a general disposition to say that the petroleum industry did not realize, at the outset of the defense program, the vast quantities of high-test gasoline that would be needed, the fact is that the industry has met all demands made upon it and that major responsibility for underestimate rests on the War and Navy Departments and other direct defense agencies and upon the vast expansion of the armament program since it was first set up. More than 15 months ago Dr. Robert Wilson, then oil consultant of the National Defense Advisory Council, submitted a program of oil requirements for a 100-day major military effort. The specific recommendation was for the military agencies to take advantage of the then existing capacity for production of high-test gas and to build storage tanks for the output at army and navy bases being developed rapidly along the Atlantic, Gulf and Pacific coasts. The recommendation was not carried out, however, due to the failure of the Army and Navy and the Defense Corporation of Reconstruction Finance Corporation to agree on a financing plan.

The priorities orders for the manufacture of steel drums for overseas shipments may give some indication of the manner in which SPAB and OPM will handle the allocations and subsequent preference rating of material requirements of the petroleum industry. Under the first of the orders, issued by the Priorities Division, general preference order M-45, manufacturers of steel drums will be required to set aside a specified inventory of 16 and 18-gage, hot-rolled sheet steel from which the drums are made. The inventory is to be used only upon specific order of the office of director of priorities. The second order, Preference Rating Order P-76, extends a rating of A-4 to deliveries of sheet metal to drum manufacturers for the purpose of replenishing the original inventory. Any sheet steel acquired as the result of this order must be held under the same conditions as the originally designated inventory. A manufacturer is not required to set aside more than the original reserve inventory, and he is not required to replace it, but it is explained, the method provided is due to the fact that orders for overseas shipment are usually handled on an emergency basis frequently within a week or two of sailings. As this situation is likely to be accentuated in the supply equipment industry, the assistance of the orders has been provided. In general, however, the plan now being formulated, but still awaiting final decision, involves the designation of petroleum as critical material. Sufficient production will be allocated to essential defense industries to cover their requirements and the remainder will be distributed through a general preference system. The products of the industry will be given an A-8 rating and producers in turn can use this priority position to obtain the necessary operating materials. Distribution among individuals and companies in the industry probably will be regulated through the district offices of OPC and the field offices of OPM, perhaps along the line of the plan now applying to the building material industry. Officials of OPM have gradually become more keenly aware of the national importance of the oil industry, not only in direct relation to the military requirements, but in keeping the whole industrial machine in efficient operation and are disposed to take whatever steps are necessary to meet its needs.

UNITED STATES AND MEXICO

LOANS to Mexico of $70,000,000 with additions to come that are expected to carry the figure well over $100,000,000, subsidization of Mexican silver by payments of $25,000,000 a year, promise of a trade convention that will give Mexican products entry to United States markets on preferential terms and a projected plan for settlement of the problem raised by Mexico's seizure of American owned oil properties were the highlights of an agreement concluded between Secretary of State Hull and Mexican Ambassador Castillo Najera in Washington on November 19.

This agreement, together with the supplementary one between Secretary of the Treasury Morgenthau and Eduardo Suarez, Minister of Finance of Mexico, covering the financial aspects of the undertaking, was rated in both capitals as a triumph for the Mexican negotiators who have persisted for months, in spite of early discouragements, in the effort to commit the United States to the extension of full financial support to the tottering economic structure of their country. Mexico's undertaking under the agreement is confined to the payment of $2,500,000 yearly in satisfaction of agrarian and "general" claims on the part of the United States until the total of these payments in addition to $6,000,000 previously paid reaches $34,000,000. Mexico deposits $9,000,000 in United States currency as a token or advance payment toward the settlement of oil claims but this sum is to be returned if no settlement is arrived at in the negotiations to be carried on by two arbitrators.

Unwillingness of the oil companies whose properties were seized by order of President Cardenas in 1938 to accept the terms offered by Mexico in compensation for their loss, led to the adoption of a special agreement for placing a valuation on these properties through joint action of the two governments. This agreement, in the form of a memorandum submitted by Ambassador Najera and accepted by Secretary Hull in behalf of the United States, contains the following provisions:

1. Each of the governments will appoint, within the thirty days following the date of this note, an expert whose duty it shall be to determine the just compensation to be paid the nationals of the United States of America whose properties, rights or interests in the petroleum industry in the United Mexican States were affected to their detriment by acts of the Government of Mexico subsequent to March 17, 1938.

Nevertheless, the provisions of this note do not apply to properties, rights or interests which may have been included in any arrangement with respect to their purchase, transfer or indemnification concluded between their owners or possessors and the Government of the United Mexican States and, in consequence, the experts will exclude from their evaluation proceedings and reports said rights, interests and properties.

2. The designated experts will hold their first meeting in Mexico City within fifteen days following the appointment last made by either government. The later meetings and other activities of the experts will take place on the dates and at the places which the experts themselves determine within the periods contemplated by this agreement and they shall be held on Mexican territory.

3. Each government shall destignate such assistants as the respective experts may require to facilitate their labors.

4. The expenses of salaries, maintenance, transportation and other incidental expenditures of the experts and their assistants, will be met by the government naming them. The joint expenses incurred during the proceedings of the experts shall be shared equally by the two governments.

5. The experts shall at all times closely collaborate and cooperate in their evaluation proceedings. They may obtain directly such data and evidence as they may consider pertinent to forming their opinion, or receive them from the interested persons and institutions and from the governments of Mexico and of the United States of America.

6. The experts shall have free access to all records in the possession of the Mexican Government, as well as to the oilfields, lands, installations, offices, buildings and any other properties whatsoever involved directly or indirectly in the evaluation. The United States expert, on the request of the Mexican expert, will ask the interested persons and institutions for pertinent evidence; when such request relates to evidence already submitted by such persons or institutions their refusal to comply with the request will bring into operation the applicable provision of paragraph 9.

7. As soon as one expert obtains or learns of any pertinent data, report, or evidence, he will inform the other. Either expert may request from the other the furnishing of any data, report or evidence which for any reason are available only to the other.

8. Within a period of two months, from the date of their first meeting, the experts shall obtain and receive all data, reports, and evidence; except that a further period of one month shall be allowed for the presentation by either expert of additional data, reports and evidence complementing, clarifying or rectifying the material obtained or received in the period of two months.

9. The experts are required to examine and appraise all the proofs obtained directly or that may be submitted to them. They shall not take into account any specific evidence submitted *ex parte* when the person or institution submitting it refuses in connection with it to furnish pertinent complementary evidence requested by the United States expert, in accordance with the provisions of Paragraph 6.

The experts shall not take into account reasons of a technical nature in formulating their decisions—be these joint or those submitted in disagreement—but will fix adequate indemnities on the basis of common rules of justice and equity and will be guided by the value of the properties, rights or interests at the time they were affected by acts of the Government of Mexico provided that these properties, rights or interests had been acquired by nationals of the United States of America prior to March 18, 1938.

10. The experts shall complete their work within five months from the date of this note. If they are in accord regarding the amount of the compensation due to the affected United States nationals, they shall submit a joint report to the two governments fixing exactly the indemnities upon which they agree. The experts shall formulate recommendations as to the manner and conditions of payment of the compensation.

11. The experts shall fix equitable interest upon the indemnity compensation they find due; this interest will apply from the date fixed by these experts up to the time of payment.

12. Both governments agree to consider unappealable the joint report resulting from the agreement of the experts, and, in consequence, as definitive, the compensation and interest fixed in such report.

13. If, within the period indicated in Paragraph 10, the experts are unable to reach agreement regarding the amount of just compensation, each one, within an additional period of one month, shall submit to his own government a separate report specifying the compensations which he considers due.

14. In the event that the two experts fail to agree, and upon the expiration of the period specified in Paragraph 13, the two governments shall, within a period of one month, initiate diplomatic negotiations with a view to establishing the amount of the compensations to be paid.

SIGN OIL AGREEMENT

U.S. capitulates in Mexican oil dispute: Above, Dr. Francisco Castillo Najera, Secretary of the Treasury Henry Morgenthau and Eduardo Suarez sign one part of the agreement that binds the United States to pay Mexico $100,000,000 or more; Right, the agreement is signed by Secretary of State Hull and Dr. Najera. No assurance of Mr. Hull's former condition of " - - prompt, effective and adequate compensation" for the expropriated oil properties is contained in the agreement. Photographs by Harris & Ewing.

15. If, within a period of five months from the date of initiation of diplomatic negotiations, as provided in Paragraph 14, the two governments do not agree upon the amount of compensation to be paid, the present agreement shall be without effect, and there shall be returned to the United Mexican States, at the request of the government thereof, the amount deposited in accordance with the pertinent stipulation of the following paragraph.

16. The two governments shall agree upon the manner and conditions of payment of the compensation found to be due to the affected United States nationals under either of the two aforementioned procedures. Such payment shall, however, be completed within a period of not more than seven years.

The Government of Mexico will deliver today, as a deposit, to the Government of the United States of America the sum of $9,000,000 (nine million dollars), United States currency, which sum shall be applied immediately on account of the compensation determined to be due.

17. The Government of the United States will facilitate negotiations between the Government of Mexico and representatives of such oil companies as may be interested in an agreement for the marketing of exports of Mexican petroleum products.

18. Nothing contained in this note shall be regarded as a precedent or be invoked by either of the two governments in the settlement between them, of any future difficulty, conflict, controversy or arbitration. The action herein provided for is considered as singular and exceptional, appropriate solely to this case, and motivated by the character of the problem itself.

Prior to the final signing of the agreement its text was twice submitted to the heads of the oil companies affected. The first occasion was Sept. 27 and in reply the representatives of the companies set forth at length their contention that the expropriation proceedings were essentially lawless in that they violated rights assured by the Mexican constitution and confirmed by subsequent agreement between official representatives of the two countries. The fundamental principle involved, it was asserted, should be recognized before negotiations for a settlement or for a valuation of the properties could be expected to lead to an equitable result. Reiterating the offer made by the companies in January 1941 to submit the legality of Mexico's action to arbitration they offered as an alternative an operating agreement under a long term contract and suggested that if neither of these proposals was acceptable to the Mexican representatives the whole matter of the oil expropriation be omitted from the negotiations then under way between the two governments. Again, on Oct. 29, the State Department urged the oil companies to agree to the terms set forth in the memorandum as finally adopted but the reply was that as trustees for thousands of American stockholders the company officials felt that they had no right to jeopardize the interests of these investors. These views were reiterated in a statement given out by W. S. Farish, president of Standard Oil Co., New Jersey, on Nov. 21. As matters stand the oil companies are out of the picture and the two governments will proceed with their attempt to settle the problem.

SOVIET OIL

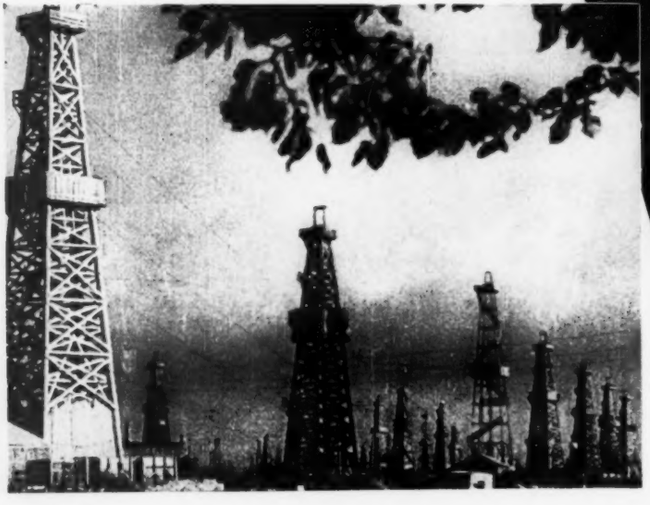
In Relation To Military Campaign

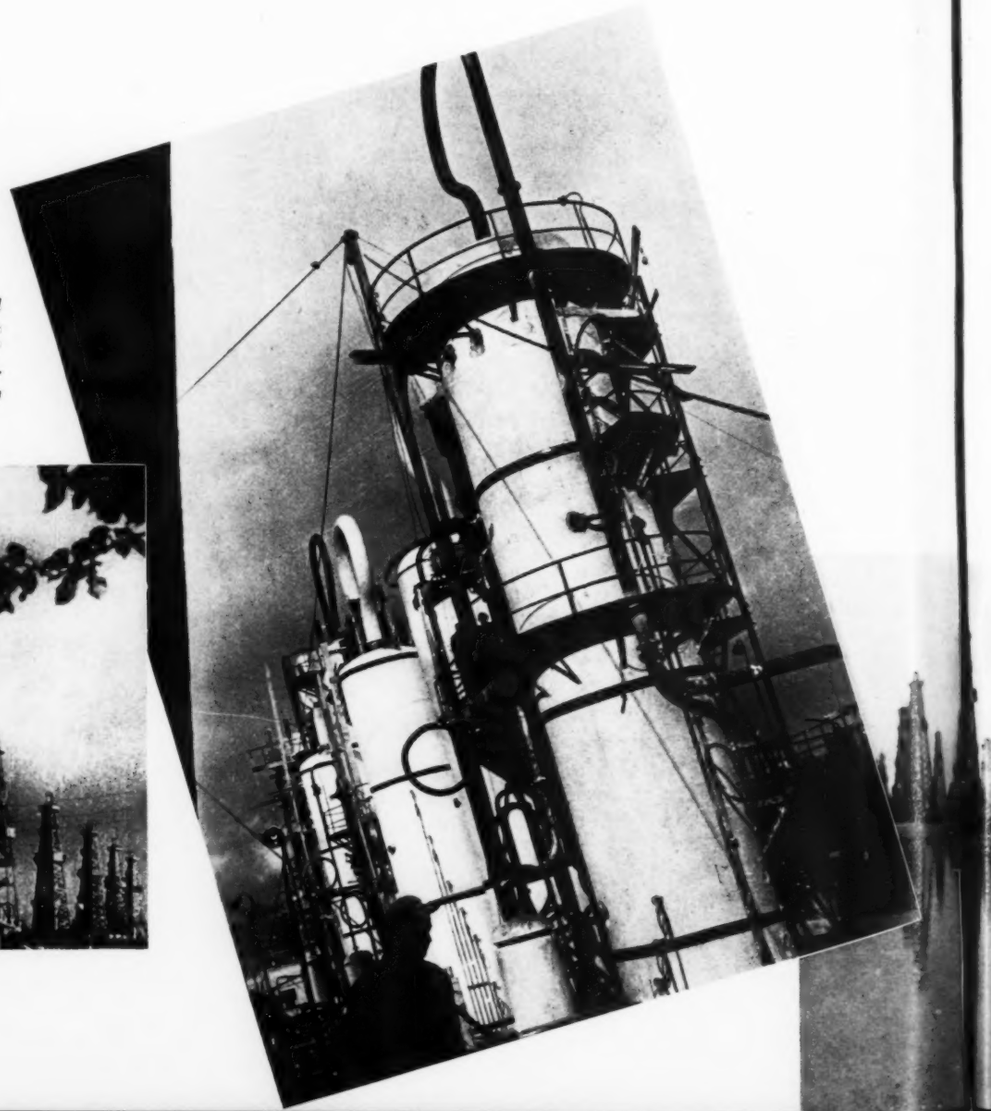
WITH a powerful Nazi force poised on the Kerch peninsula in the Eastern Crimea and other divisions having seized Rostov, another long anticipated chapter in the war opens; the drive toward the only adequate oilfields within reach of the German army. While no shortage of petroleum is apparent yet in the Nazi conduct of the war, it has been obvious since the start, that sooner or later vast new supplies would be required if Germany was to continue its course of world conquest. Much of the Wehrmacht's strategy in the conduct of the conflict has been based on considerations of oil supply; a vast storage had been built up in Germany before the war; production of synthetic petroleum had been far advanced and every effort was made to assure the continuance of Roumanian supplies. Perhaps these preparations would have been sufficient had the war followed the blitz pattern originally designed by the German high command as most suitable for powerful mechanized thrusts by an army that did not have access to an abundance of petroleum.

Developments during the past year including the revolt in Yugoslavia, time lost at Crete, the actual beginning of the flow of American supplies to British forces and finally the unexpectedly effective resistance of the Soviet armies, all conspired to delay the accomplishment of the complete conquest of Europe. Since the invasion of the Soviet Union no temporary lull has permitted the German forces to accumulate the necessary reserve of oil required for the extended struggle that is now unfolding. But even from the first day of the war eventual seizure of the Caucasian oilfields obviously occupied an important place in Hitler's conception of the new order in Europe. Europe, self-sufficiently organized under the Nazis but lacking in indigenous supplies of petroleum would have been utterly incompatible with the detailed and comprehensive plans evolved in Berlin. Russia was the obvious source. But the Soviets, controlling perhaps the largest reserve of oil in the world, had failed since 1932 to keep pace in petroleum production with their own mounting domestic demand. Ten years ago the Soviet Union was an important, even a sinister factor in the world markets; since then her exports have steadily declined until at the outbreak of the European war they little more than balanced imports from the United States. Industrialization of the country, mechanization of agriculture continued through the past decade at a rising tempo that almost paralleled the plans of the Second and Third Piatiletka. But oil production, exploration and drilling continued to fall behind plans, and while there was a small yearly increase in output it has hardly been sufficient to serve the other components of the Soviet planned economy. Imposing on top of this growing demand the paramount requirements of a huge Red Army destroyed any hope that the Nazis may have entertained of securing an adequate supply for all Europe from the Russians by peaceful means. No surplus for export would be available while the Red Army existed with its huge military demand. It became necessary to remove this demand by destroying the army and to assure the efficient production and uninterrupted flow of oil to Europe by controlling the fields.

What are the Russian oil reserves? Where are they located in relation to the invasion? How far have they been developed? What is left if the Caucasian fields are captured? Without European Russia, could the Red Army hope to keep the field on the basis of oil available in Eastern Russia?

The accompanying map shows the location of the principal oilfields, refineries and pipelines in





Below, oilfield at Ishimbayevo between the Volga and the Urals where the Soviet have been trying for ten years to develop an Eastern Oil Base or "Second Baku" which would be of great importance now. Right, cracking unit at Baku, key to Soviet industry in production and refining. Pictures by Sovfoto.

While Baku, 900 Miles Across Rugged Terrain from Advanced German Posts, Is The Key to Russian Oil Situation, The Red Army Has Small Production, Refining Capacity in Reserve Behind the Urals.

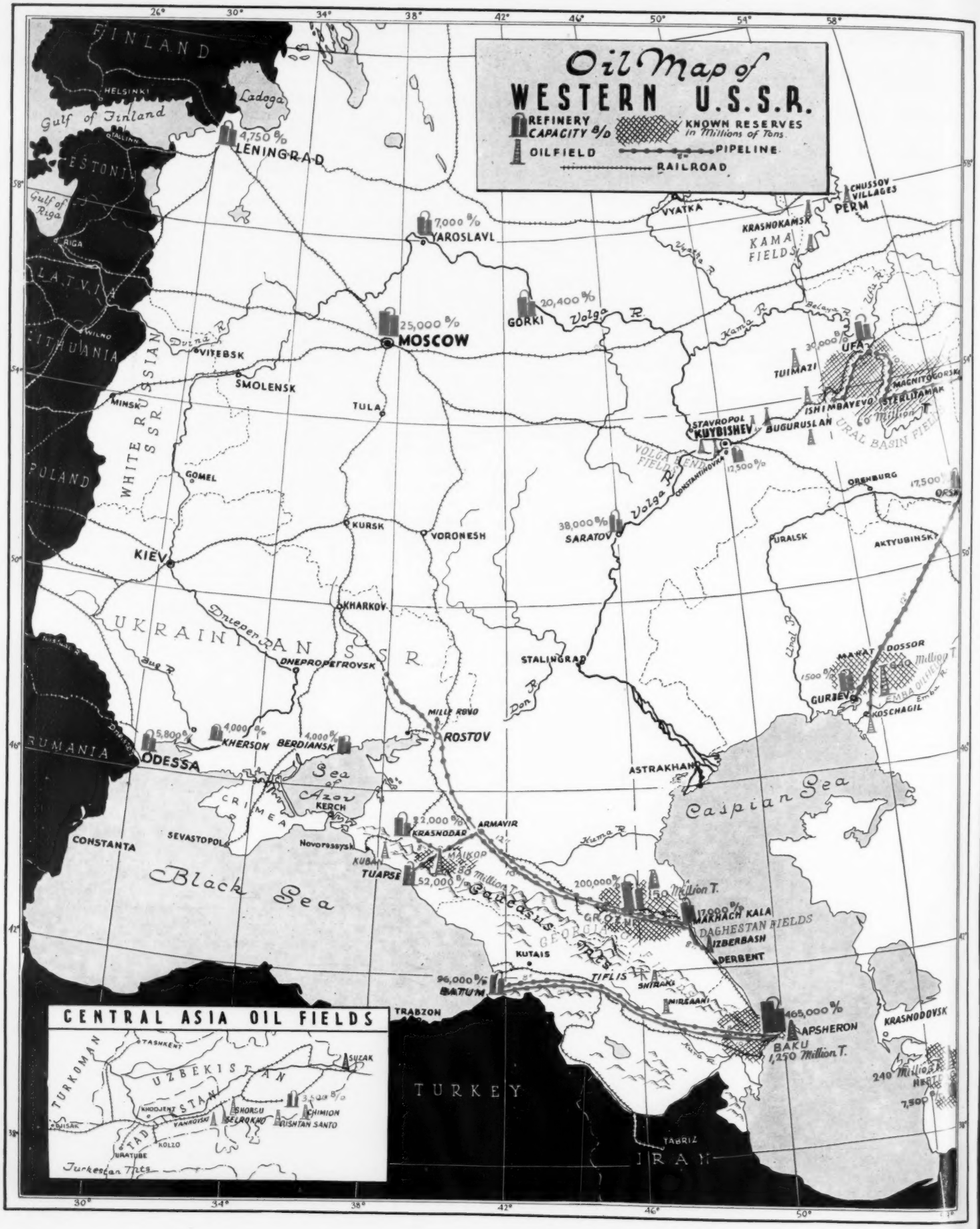
Russia. Even if the armies of General Timoshenko entrenched about Rostov and the Taman peninsula are defeated or eliminated the German forces are still 900 miles from Baku, the principal source of Soviet oil. Across the Caucasus, from the Taman peninsula in the northwest, to the Apsheron peninsula in the southeast run the Transcaucasian mountains rising to 18,000 ft. at Mount Elbrus and crossed by only one practicable pass at Darial. This historic route across the mountains presents an almost insurmountable obstacle to military penetration. There is a second and perhaps more accessible gateway to Baku. Where the mountains reach the Caspian they drop off to low foothills and finally a flat plane along the shore; this is known as the Derbent Gate and has served as a traditional invasion route for thousands of years.

Despite the possession of tremendous known reserves, the increase in rate of production in Russia has been low out of all proportion to the efforts that have been expended on this phase of Soviet endeavor during the past ten years. Prof. I. Gubkin, whose death a few years ago deprived the U.S.S.R. of a world famous geologist, estimated possible Soviet oil reserves at 20,000,000,000 bbl. Unquestionably future explorations will reveal the presence of further substantial quantities of oil. Geophysical and even geological exploration has scarcely made a beginning in Russia. These estimated reserves are divided between Baku, 9,659,000,000 bbl., Grozni, 1,006,000,000 bbl., Maikop-Kuban, 598,000,000 bbl. and areas east of the Urals aggregating some 9,477,000,000 bbl. Starting with these reserves, and through the study of production and refining it will be observed that Baku is the key to the present Russian oil industry. It may be that at some future date, but certainly not in less than a decade, the "Second Baku" that has been the aim of the Soviets will become a reality; but for the present, and as far as the war is concerned, Baku is vitally important. Later estimates of Prof. Gubkin doubled this total reserve figure. Qualified independent experts have estimated that the Soviet Union possessed at least 11,700,000,000 bbl. of known reserves amounting to 16 percent of the world's total known reserves.

As a former Georgian oil worker, Stalin himself has always fully appreciated the economic and military significance of the Soviet petroleum industry. During the late 20's and early 30's oil exports furnished a valuable source of foreign exchange for the purchase of machinery not readily available within the Soviet Union. As succeeding Five Year plans progressed, it was found that oil production lagged behind other phases of the plan, with the result that oil exports had to be reduced to assure supplies for internal requirements. During the last year before the war, Soviet exports had fallen to about 800,000 bbl. or but little more than was imported into Russia via the Pacific from the United States. In 1931 the Soviet Union produced 162,146,000 bbl. The following year production had dropped 4.36 percent to 155,078,000 bbl. and remained at about this figure through 1933. Production increased 12.76 percent in 1934; 4.12 percent in 1935 and 10.70 percent in 1936. Since that year production has increased very gradually and by 1940 had reached only 222,600,000 bbl. far below the quota set by successive Five Year Plans. In the ten years between 1931 and 1941 production will have increased by about 42 percent as a result of the best efforts and skill that the U.S.S.R. could bring to bear on this problem. On the basis of this increase, obtained largely from fields in operation at the beginning of the decade, rather than by new discoveries, it may be assumed that little could be done in the next few years to develop production elsewhere in Russia on a scale sufficient to offset the loss of Baku should the German army succeed in crossing the barren wastes of the north central Caucasus for an assault on the Apsheron peninsula.

A glance at the accompanying map reveals that the distribution of the Soviet oil industry, considered from a military standpoint, divides naturally into the Caucasus, including Baku, Grozni, Kuban-Maikop and a few small fields in Georgia south of the Trans-Caucasian mountains. This area produces 86 percent of all Soviet oil. The Caucasus is subdivided into Trans-Caucasus, south of the mountains in which is located the Baku group of fields from which Russia derives 72 percent of its oil; and North Caucasus north of the mountains in which is located the Grozni-Daghestan group of fields responsible for six percent of the Russian production, and the Maikop-Kuban fields, producing 7.5 percent of Soviet oil. In connection with the last two groups it is important to note that Maikop-Kuban is of growing importance and it is anticipated that these fields will ultimately become a substantial factor in the industry. These fields run eastward from the Black Sea only a short distance below Novorossisk and less than 120 miles from the Kerch Straits which the German army is now engaged in forcing. Grozni group of fields on the other hand appears to be of decreasing importance. In 1932 it was responsible for 35 percent of all Soviet production; at present it produces only six percent. This group of fields is fully 500 miles east of Kerch with rugged country lying between the two points. The second major division of the Russion oilfields from a military point of view is the Ural-Volga, Emba and those east of the Ural mountains which it is unlikely that the German army would ever consider it desirable to reach. The main fields in this area are the Ural-Volga fields starting with Perm on the 58 deg. of north latitude and including the Ural Basin group, principal of which is the Ishimbayevo field. This area is responsible for at least eight percent of all Soviet oil. Also belonging to this

A view of Baku from the Caspian sea. One of the world's greatest oilfields, Baku now produces 72 percent of all Russian oil and appears to be the objective of the German drive from Rostov and Kerch. Picture by Sovfoto.


Oil Map of
WESTERN U.S.S.R.
REFINERY CAPACITY B/D
KNOWN RESERVES in Millions of Tons.
OILFIELD
PIPELINE
RAILROAD
FINLAND
HELSINKI
Ladoga
Gulf of Finland
TALLINN
ESTONIA
Gulf of Riga
RIGA
LATVIA
LITHUANIA
WILNO
POLAND
WHITE RUSSIAN S.S.R.
Dvina R.
VITEBSK
SMOLENSK
MINSK
GOMEL
TULA
MOSCOW
4,750 B/D
LENINGRAD
7,000 B/D
YAROSLAVL
20,400 B/D
GORKI
Volga R.
25,000 B/D
KIEV
KURSK
VORONESH
KHARKOV
UKRAINIAN S.S.R.
Dnieper R.
DNEPROPETROVSK
Bug R.
RUMANIA
5,800 B/D
ODESSA
4,000 B/D
KHERSON
4,000 B/D
BERDIANSK
MILLEROVO
ROSTOV
Don R.
STALINGRAD
SARATOV
38,000 B/D
Volga R.
KONSTANTINOVKA
12,500 B/D
STAVROPOL
KUYBISHEV
BUGURUSLAN
VOLGA-EMBA FIELDS
URAL BASIN FIELDS
ORENBURG
17,500 B/D
ORSK
URALSK
AKTYUBINSK
Ural R.
MAKAT
DOSSOR
1500 B/D
GURIEV
KOSCHAGIL
EMBA OILFIELDS
Emba R.
ASTRAKHAN
Caspian Sea
Sea of Azov
KERCH
CRIMEA
SEVASTOPOL
Novorossysk
CONSTANTA
Black Sea
KRASNODAR
32,000 B/D
ARMAVIR
MAIKOP
KUBAN
TUAPSE
52,000 B/D
Caucasus Mts.
Kuma R.
200,000 B/D
150 Million T.
17,000 B/D
MAKHACH KALA
DAGHESTAN FIELDS
IZBERBASH
DERBENT
GROZNY
GEORGIAN FIELDS
KUTAIS
96,000 B/D
BATUM
TIFLIS
SHIRAKI
NIRSAANI
TRABZON
TURKEY
465,000 B/D
APSHERON
BAKU
1,250 Million T.
KRASNODOVSK
240 Million T.
7,500 B/D
TABRIZ
IRAN
CHUSSOV VILLAGES
PERM
VYATKA
KRASNOKAMSK
KAMA FIELDS
Kama R.
Belaya R.
Zilim R.
30,000 B/D
UFA
TUIMAZI
ISHIMBAYEVO
MAGNITOGORSK
STERLITAMAK
60 Million T.
CENTRAL ASIA OIL FIELDS
TURKOMAN
TASHKENT
UZBEKISTAN
SUIZAK
KHODJENT
TADJIKISTAN
VANKOVSKI
SHORSU
SELOKKO
3,500 B/D
CHIMION
KISHTAN SANTO
ADJISAK
KOLZO
URATUBE
Turkestan Mts.

division are the Emba fields, just north of the Caspian, noted mainly for their suspected reserves which are believed to exceed substantially the figure of 640,000,000 tons assigned to them by Prof. Gubkin. At present Emba produces only two percent of Soviet oil. All other fields, including Neftedag on the eastern shore of the Caspian, the oilfields of Central Asia and small production on the Island of Sakhalin in the Pacific account for four to five percent of the total and are widely scattered.

Thus it may be seen that the Caucasus producing at the rate of 525,000 bbl. per day is responsible for 86 percent of all Soviet oil. All other fields that may be assumed to be safely beyond the reach of any invasion produce 85,000 bbl. per day, or 14 percent of Soviet oil. Of this latter supply, the production from Sakhalin cannot enter into calculations based on operations in the west, but output from this island is relatively unimportant accounting for only 1.41 percent of the total. Central Asia is likewise of dubious value for operations in European Russia. Actually then, the Ural-Volga and Emba fields are capable of providing some 10 percent of Russia's present production, enough to provide for extremely limited military operations in the event the Caucasus should be lost. The Ural-Volga has long been considered by Russian economists the appropriate location for what they have termed the "Second Baku" and it has been a cardinal principal of Soviet planning to decrease the dependence on Baku by stimulating development

One of the modern worker's apartments built at Baku by the Soviet Union in an effort to transform former "Black Town" into a model industrial city.

in this section. From 1931 to the present, this policy has succeeded in increasing production from Ural-Volga from 43,000 bbl. in 1931, a mere 0.03 percent of Russia's total production, to 18,500,000 bbl. in 1940 representing 8.31 percent of all U.S.S.R. output. It is highly unlikely that this production can be significantly increased in the near future, particularly under wartime conditions. The importation into Russia during the past few years of over 100 portable rigs from the United States may have had some part in increasing Ural-Volga output by 32 percent in 1940 over 1939, but substantial imports of such heavy equipment at this time are out of the question. Future intensified exploration will no doubt be directed toward the Ural-Volga region.

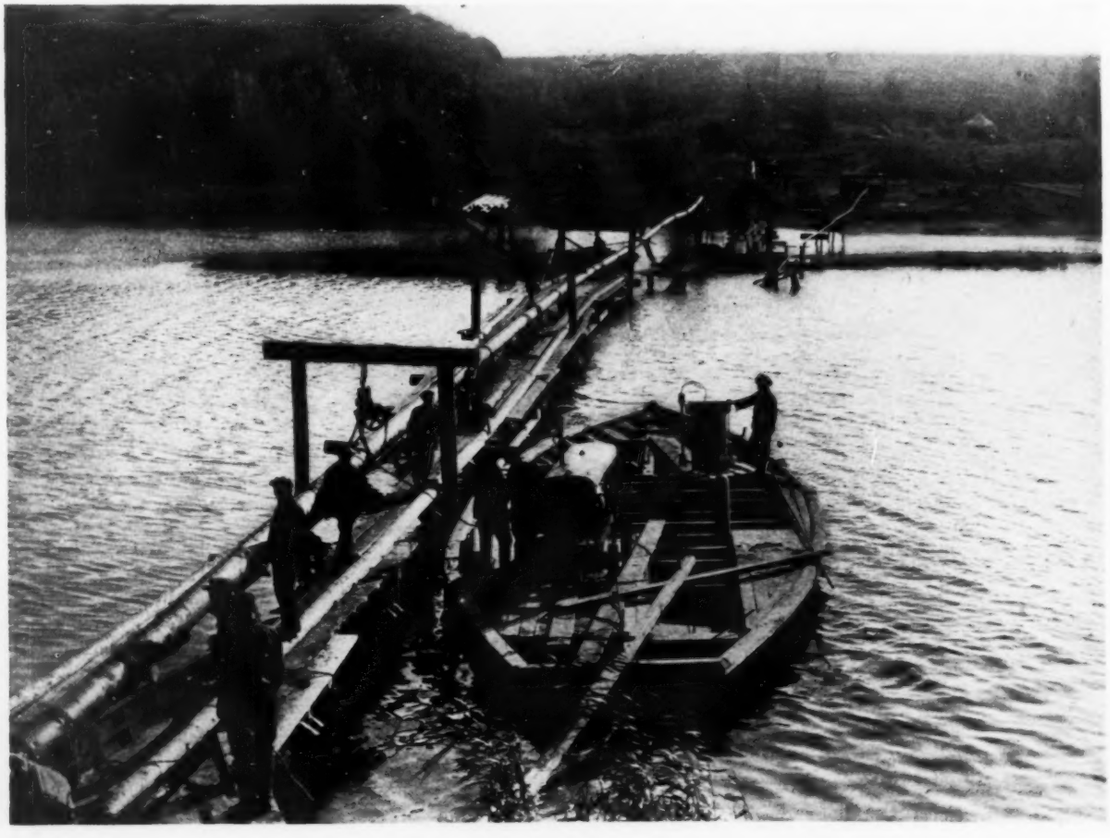
The location of Soviet refineries and their capacities are shown on the accompanying map. These too fall into four main divisions for mili-

Daghestan, an important unit of the Grozni-Daghestan group extending to the shore of the Caspian Sea north of the Trans-Caucasian mountains. Picture by Sovfoto.

tary considerations. The refineries at Odessa, Kherson, and Berdiansk have fallen into German hands and it may be assumed that the refinery at Leningrad has been rendered inoperative as a result of aerial bombardment and the present seige. All these plants together have a charging capacity of 18,550 bbl. per day or only 1.78 percent of Soviet refining capacity. The next division comprises those units west of the 42 deg. of east longitude including Yaroslavl, Moscow, Krasnodar, Tuapse and Batum with a daily charging capacity of 202,000 bbl. representing 19.35 percent of Soviet refining. These plants may be considered to be in imminent danger with the possibility that some of them have already been damaged. If they are lost over one fifth of Soviet refining capacity will be lost. By far the most important group of refineries is located at Baku, Grozni, Makhach Kala. If the German army penetrated this far, it might well be assumed that they would have captured or destroyed the plants at Gorki and Saratov in the north. Altogether this would account for an additional 70.91 percent of Soviet refining, since these refineries have a charging capacity of 740,400 bbl. per day. Should the Red Army lose all three of these important divisions of the refining industry, they would still have the plants east of the Urals with a combined capacity of 83,200 bbl. per day or 7.98 percent of present Russian refining capacity. This would include refineries at Ufa, Orsk, Constantinovka, Guriev, Neftedag and Varinsk. Two small refineries in the east would be of little practical value for military supplies: the 3,500 bbl. per day unit at Chimion in Central Asia and the 5,000 bbl. per day refinery on the Amur River near the Pacific coast.

As to transportation, there are some 30,000,000 tons of petroleum to be moved yearly. By far the greater part—13,000,000 tons—is moved by rail in 15,000 to 18,000 tank cars. Another 11,000,000 tons are transported over the extensive system of waterways serving central Russia via the Volga. Finally 6,000,000 tons are handled by pipelines. The most recent figures available indicate about 75 tugs handling 200-220 dumb barges, over 100 motor tank barges and a fleet of 30 to 40 seagoing tankers used on the Caspian and Black Seas. The pipelines include the important double line from Baku to Batum consisting of one eight inch and one ten inch duct originally built to supply the export market. This was the route of the first pipeline in Russia built before nationalization of the industry. After the revolution, a line was built from Grozni to Tuapse during the time when high hopes were entertained for future increases in Grozni production. A refined products line was also laid from Grozni through Armavir to Rostov where a large tank farm was located. From Rostov this line went to Nikitovka whence petroleum products were distributed to the important industrial and agricultural centers of the Ukraine. It was planned to continue one branch of this line to Dnepropetrovsk and another northward to Voronesh but these plans have not as yet been carried out. It may also be seen on the accompanying map that there is a short line—66 miles of eight inch—from Maikop to the refinery at Krasnodar and a 96 mile eight inch line from Makhach Kala to Grozni. When production at Grozni dropped off, this line was used to transport Baku crude, shipped via the Caspian, from the coast to the surplus refinery capacity built in anticipation of a rising tempo of production at Grozni. Other shorter lines lead into Grozni from the adjacent Molgabek and Gorski Mountain fields that are included under the general heading of the Grozni group. Outside the Caucasus there are only two important systems of pipelines. First, the 440 mile 12 inch line carrying Emba crude to the refinery at Orsk and, second, the Ishimbayevo to Ufa line in the Ural-Volga region. All these lines are modern and have Diesel power in the pump stations.

As to individual groups of oilfields in Russia, Baku as mentioned is the oldest and by far the most important. During 1940 these fields produced some 161,000,000 bbl. of crude equal to 72 percent of total Soviet production. The fields occur along the south shore of the Apsheron Peninsula extending down the mainland for some distance south; there is some production from areas that were formerly occupied by the Caspian Sea and have since been filled in to permit drilling. Oil is obtained from over 30 producing sand horizons with a cumulative thickness of some 6,000 ft. Already between 7,500 and 8,000 oil wells have been drilled. Only a



Constructing a pipeline in Russia a few years ago: transportation has always been a difficult problem and every effort has been made to use pipelines to relieve the pressure on railroads. The accompanying map shows the relatively few lines serving the Soviet oil industry. Photograph by Sovfoto.

Soviet oilfields could easily be damaged due to the presence of oil and waste on the surface. In the above photograph by Margret Bourke-White for Pictures, Inc., the wooden derricks, pools of oil and inadequate tankage are clearly revealed.

few of these wells are producing by natural flow; the others average about 25 bbl. per day on the pump, 15 bbl. per day bailing and 220 to 230 bbl. per day on gaslift. The majority of wells produce from 2,500 to 3,500 ft. but there are numerous exceptions with a number of wells recently drilled to 8,000-10,000 ft. The fields are almost completely electrified as to drilling and pumping with some Diesel rigs in use on extensions of existing fields and semi-wildcats. The spacing pattern is very close by American standards with one well to five acres in newly developed areas; in the older part of the field before a spacing program was introduced, over 4,000 wells were drilled in an area of some 6,400 acres.

Grozni has in the past been considered the second most important area in the Soviet Union. This group of fields lies north of the mountain range in the foothills and Grozni itself is the capital of the autonomous republic of Chechen. In 1940 Grozni produced 6.06 percent of all Soviet oil, a total quantity of 13,500,000 bbl. representing a great decrease from the 55,433,000 bbl. produced in 1932. The fields are situated on northwest-southeast trending anticline and originally produced in 1821 from hand dug pits. Modern development dates from 1893 when a 400-ft. well came in for 11,000 bbl. per day. Thereafter a number of big producers were drilled but their life was not long in comparison with the wells at Baku. There are approximately 3,200 oil wells. Present production is generally from 5,000 to 6,000 ft. The crude is of paraffine base with 24 percent gasoline content. Well spacing here is one well to 10 acres. Included in the North Caucasus group are the Daghestan fields on the shore of the Caspian east of Grozni. Izberbash is the most important field in this group having 70 to 80 wells producing a high gravity crude containing 59 percent of light products. Other fields in the Daghestan group are the relatively undeveloped Kaya Kent, Achi-Su and Berekei fields having perhaps 40 to 50 wells between them.

Maikop-Kuban fields account for 7.46 percent of Soviet production, having produced 17,000,000 bbl. in 1940. The crude from these fields is light, occurs chiefly at 1,500 to 2,500 ft. and is accompanied by a natural gas rich in propanes and butanes. The wells are spaced one to five or six acres. A few wells in the Kuban field produce at the rate of 200 to 300 bbl. per day by natural flow.

Emba at the northern end of the Caspian sea is possibly more important as a future reserve than for its present production. Suspected reserves are estimated at 640,000,000 tons and the general area may cover 230,000 sq. miles with at least 200 salt domes. Reports as to the number of wells in this group are incomplete but it is estimated that 3,400,000 bbl. were produced in 1940. Recently efforts have been made to speed development of Emba due to its relatively safe location. A few wells have been drilled here to 8,000 to 10,000 ft.

The Ural-Volga region produced 18,500,000 bbl. in 1940 accounting for 8.31 percent of Soviet output. Plans for development were drawn up in 1914 but were delayed by the war; actual exploration of this area did not begin until 1930. Soviet geologists have estimated that on the basis of 10 acre spacing, at least 10,000 wells could ultimately be drilled in this region. There are however, only about 400 to 500 wells at present. Plans looking toward the establishment of these fields as the Eastern Oil Base of the third Five Year Plan called for a production of 50,000,000 bbl. by 1942 with the completion of 10 or 12 refineries. These plans however, are far from fulfillment.

In conclusion it is apparent that the Soviet oil industry depends to a tremendous extent on Baku alone: while Baku is not in immediate danger, it is quite possible that it might be lost to Russia in the coming spring or summer campaign if the German army can cross 900 miles of rugged and difficult terrain. The loss of Baku, with the oil regions that would be bound to fall before the Germans could reach that point would deprive the Soviet of 86 percent of her total production and 92 percent of her refining capacity. Unquestionably a severe blow, it is not inconceivable that a formidable force still might be maintained west of the Ural mountains as a threat to the Nazi flank, and such forces would have available a total production of 85,205 bbl. per day and a refining capacity able to process 83,200 bbl. per day. It may be seen from the geographical distribution of the Soviet oil industry that the industrial plans evolved in 1928-29 were fundamentally sound. The importance of establishing an eastern oil base is fully proved by recent events. The failure to fulfill these plans completely may yet prove embarrassing to Soviet military strategy should the German army succeed in crossing the Caucasus.

LAKE CHARLES

Refinery Sets Pattern For New Construction

Continental's New 10,000 Bbl. per Day Plant Forms an Integrated Step in the Continuous Flow of Crude & Distillate From Formation to Finished Product—Designed After Careful Evaluation of Available Charge, Its Output of 1000 Bbl. per Day of 100-Octane is Proving Most Timely.

OIL FLOWS in one practically continuous stream from the producing sand through the refinery to the tank car or tanker in the new $4,000,000 refinery which Continental Oil Company has recently completed at Lake Charles, Louisiana. In this plant, every step in the manufacture of petroleum products, from the entrance of the crude oil at the bottom of the well to the delivery of the finished product, has been integrated into one smooth-running flow, resulting in one of the highest rates of recovery of finished products on record. Meshing of the various processes was made possible by a variety of circumstances, chief of which were the construction of a brand new refinery and the adaptation of that plant directly and specifically to the type of raw material available.

For several years, Continental has been developing large oil fields in Louisiana, the most important being at Tepetate and Ville Platte. During this period, Continental has also been pioneering in pressure maintenance, returning gases to the producing horizons to maintain bottom hole pressures and reduce waste. At Tepetate and Ville Platte, the company has built two of the largest pressure maintenance plants in the world, operating in conjunction with natural gasoline plants. In these two plants crude is stabilized as it comes from the ground, resulting in the production of large amounts of propane and butane, highly volatile products now of the utmost importance in connection with the supply of 100-octane aviation fuel required by the national defense program. Construction of the new refinery took into account the availability of these materials. By piping the lighter fractions, blended with natural gasoline, to the refinery, it has been possible to utilize everything produced at the wells—crude, natural gasoline, and the lighter hydrocarbons—efficiently and economically in a manner that might serve as a model for new refineries.

The new refinery was built to provide natural

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Above, office building of the new Lake Charles refinery of the Continental Oil Company; spheroid casinghead storage tanks in the background.

Close up of one of the alkylate storage tanks: the plant includes cracking, alkylation and polymerization units.

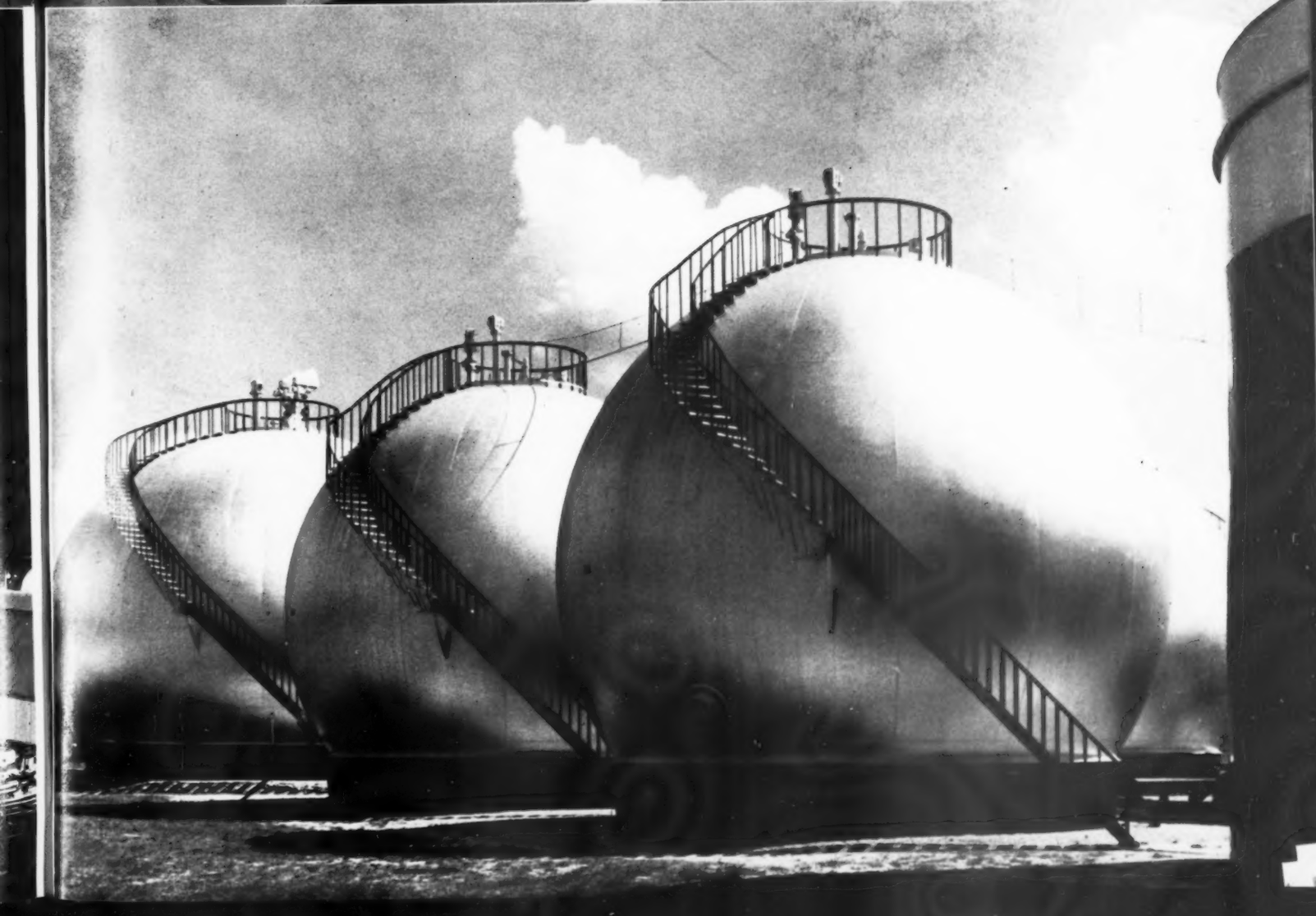
Master control room where every variation in flow, temperature and pressure is recorded and regulated.

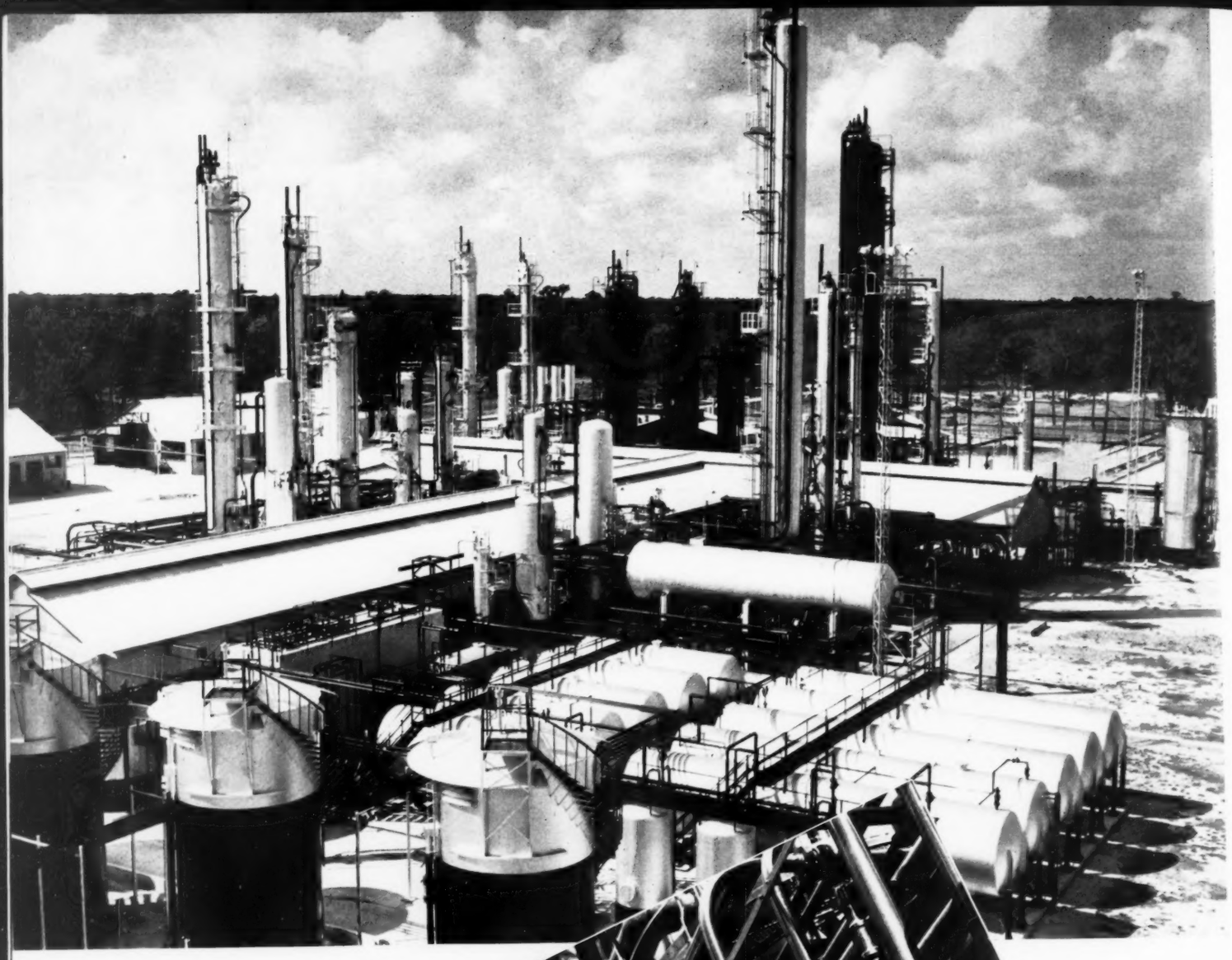
gasoline stabilization, crude skimming, thermal cracking, thermal polymerization, and alkylation, taking stocks directly from pipelines and threading them through the maze of processes in a continuous stream which makes for the utmost in efficiency and conservation. Long periods of study and research were spent by engineers of the Kellogg Construction Company, builders of the plant, and Continental engineers, chemists, manufacturing experts, and even drilling specialists before the actual work on the plant was started during the past year.

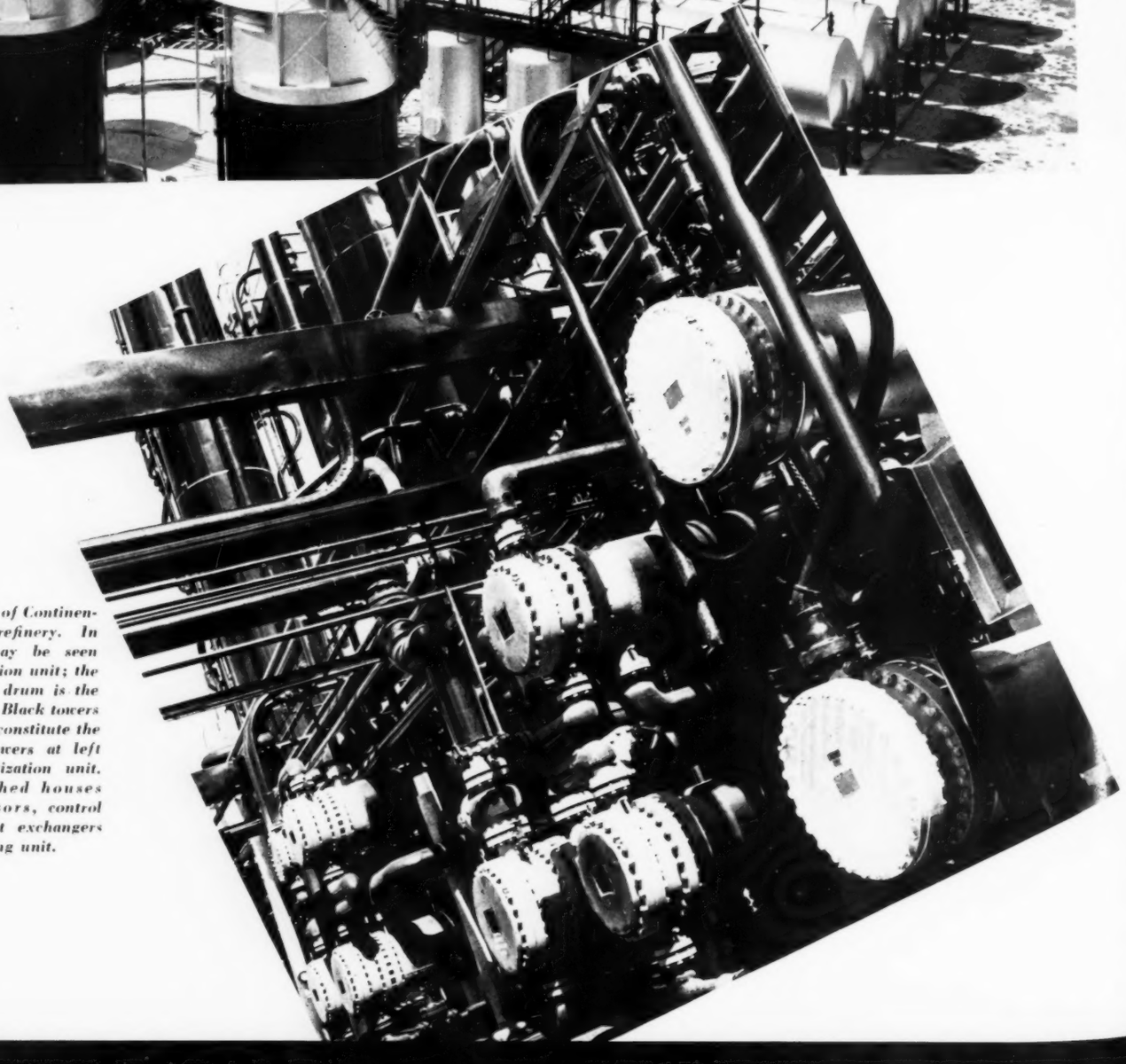
Polymerization, stated in its simplest terms, is the combining or tying together of two hydrocarbon molecules, normally gaseous and lighter than casinghead gasoline, into a heavy molecule in the gasoline range. It is carried out in two ways — thermally and catalytically. Thermal polymerization will work on either field or refinery raw material—on uncracked or cracked gases. Polymer gasoline is a product with a high anti-knock value, between 75 and 80 octane, good response to tetraethyl lead, and a high blending value, ranging from 90 to 100 octane depending on the proportion of the blend. To illustrate this latter point, a blend of nine parts of 60 octane gasoline and one part of 75 octane

Above, double boilers serving the power plant equipped with Thermix stacks. Below, a general night view of the plant looking northwest; the transfer pump manifold may be seen at lower right, the alkylation unit is directly above the manifold, the polymerization unit is in the center of the picture and the cracking unit is in the background.

Left, Westinghouse turbine generators in the power house; below casinghead storage. The plant was designed to take full advantage of the distillate produced by Continental at Tepetate and Ville Platte as well as the crude charge.







Above, general view of Continental's Lake Charles refinery. In the foreground may be seen tanks of the alkylation unit; the elevated horizontal drum is the alkylation reactor. Black towers in the background constitute the cracking unit. Towers at left form the polymerization unit. The T-shaped shed houses pumps, compressors, control room. Right, heat exchangers in the cracking unit.

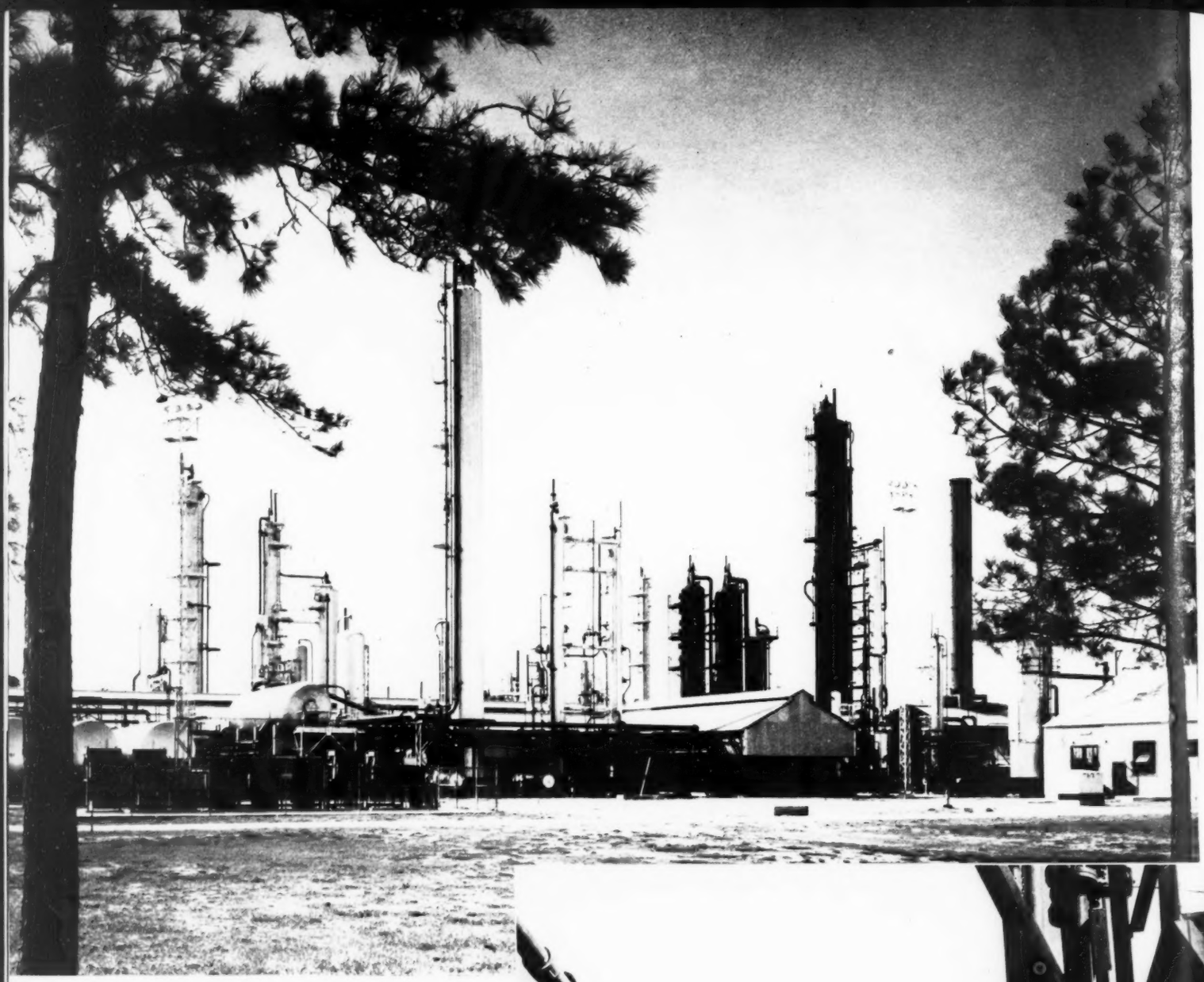
polymer gasoline, which should by calculation test 61.5 octane, actually results in a 63 octane blend, proving 90 octane blending value for the polymer.

Alkylation is the relatively new process for producing high octane gasoline material. It was discovered and developed as a result of increasing chemical knowledge of light hydrocarbons. The product, alkylate, is a mixture of high octane hydrocarbons with iso-octane predominating, with good tetraethyl lead responsiveness, having a 90 to 95 A.S.T.M. octane number and high blending value. Because of its high anti-knock and great chemical stability, it is particularly valuable as a predominating constituent of the highest types of aviation gasoline, used where high pay loads or critical character of service makes cost of fuel a secondary consideration. From uncracked field gases a component called isobutane is separated, and from cracked refinery gases butylene is extracted, both belonging in the four-carbon atom class, comprising the heaviest of the normally gaseous hydrocarbons. By passing the two compounds at low pressure and low temperature through a catalyst, a molecule of iso-butane and a molecule of butylene are joined to form a heavier molecule of alkylate.

The following brief description indicates how the stabilized crude stocks and the natural gasoline-butane-propane mixtures are processed through the refinery. The natural gasoline-butane-propane mixtures are stabilized at the refinery to a 14 lb. or a 22 lb. natural gasoline, depending on the seasonal needs. The overhead from this stabilization is principally propane, isobutane and butane, vital vapors in the alkylation and polymerization units of the plant in which they are treated as will be described.

The stabilized crude enters the refining process through a series of heat exchangers before entering the furnace, being pumped countercurrent with the intermediate reflux in the crude tower; countercurrent with the top reflux in the bubble tower; countercurrent with dark gas oil being returned to the evaporator; and when necessary, through an auxiliary exchanger. From the furnace the crude is fed to the crude tower, from which gasoline is taken overhead and run to a debutanizer tower, where butane is removed and transferred to the gasoline separator in the cracking unit. Reforming naphtha is taken from the crude tower as a side cut. Kerosene, distillates and Diesel fuel may also be taken from the crude tower as side cuts. These products are washed with a light caustic when necessary, and stored for sale. Topped crude from the base of the crude tower is taken to the top section of the cracking unit evaporator, where it joins with

Gray towers at left and clay storage drum in foreground.



Above, general view of the plant with the poly unit on left, the alkylation unit in center and the cracking unit on the right. Right, tank cars at the loading rack on a siding near the plant.

heavy recycle. The resulting mixture is then subjected to cracking conditions in a furnace coil and soaking drum and is returned to the bottom section of evaporator, where it joins stock from several other units. Bottoms from the evaporator tower are marketed as fuel oil.

The overhead vapors from the evaporator tower pass to the bubble tower. From the bubble tower, cracked gasoline is taken overhead to the clay contact towers, then to the after-fractionator tower, and finally to the cracked gasoline debutanizer tower. The overhead from this debutanizer goes to the depropanizer feed drum in the polymerization unit, while the bottoms from the debutanizer tower are blended with normal butane, washed with caustic, transferred to the copper-treating plant, and stored for blending to produce motor-grade gasoline. Bottoms from the bubble tower constitute clean charging stock

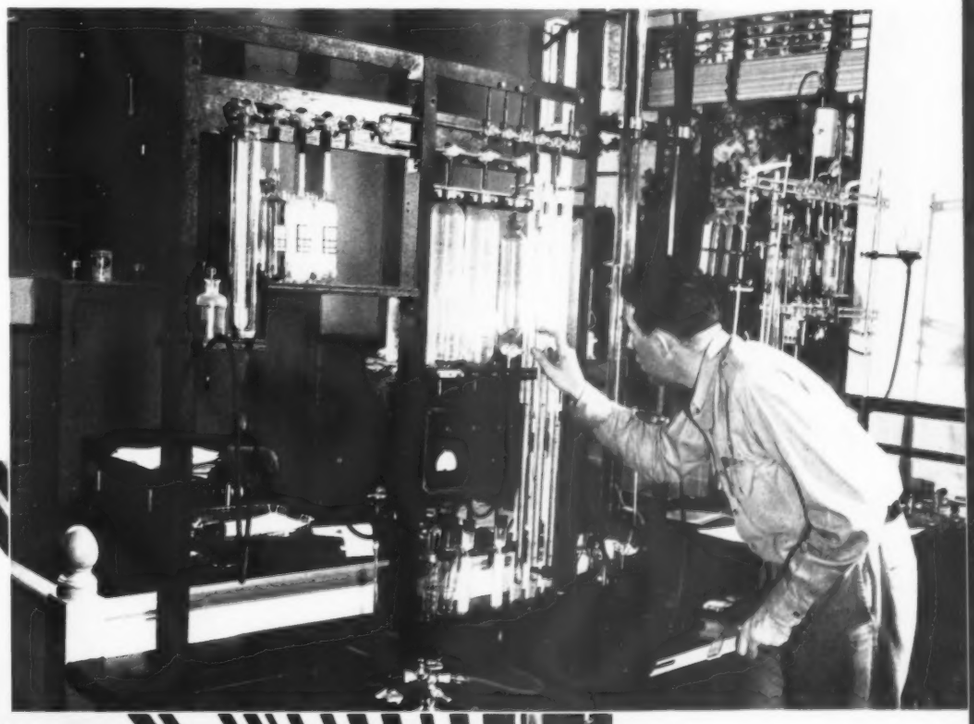
which is put through the gas oil cracking coil and soaking drum, and then enters the evaporator. Butane and reforming naphtha are charged to a reversion furnace and the resulting combined outlet material also enters the cracking unit evaporator.

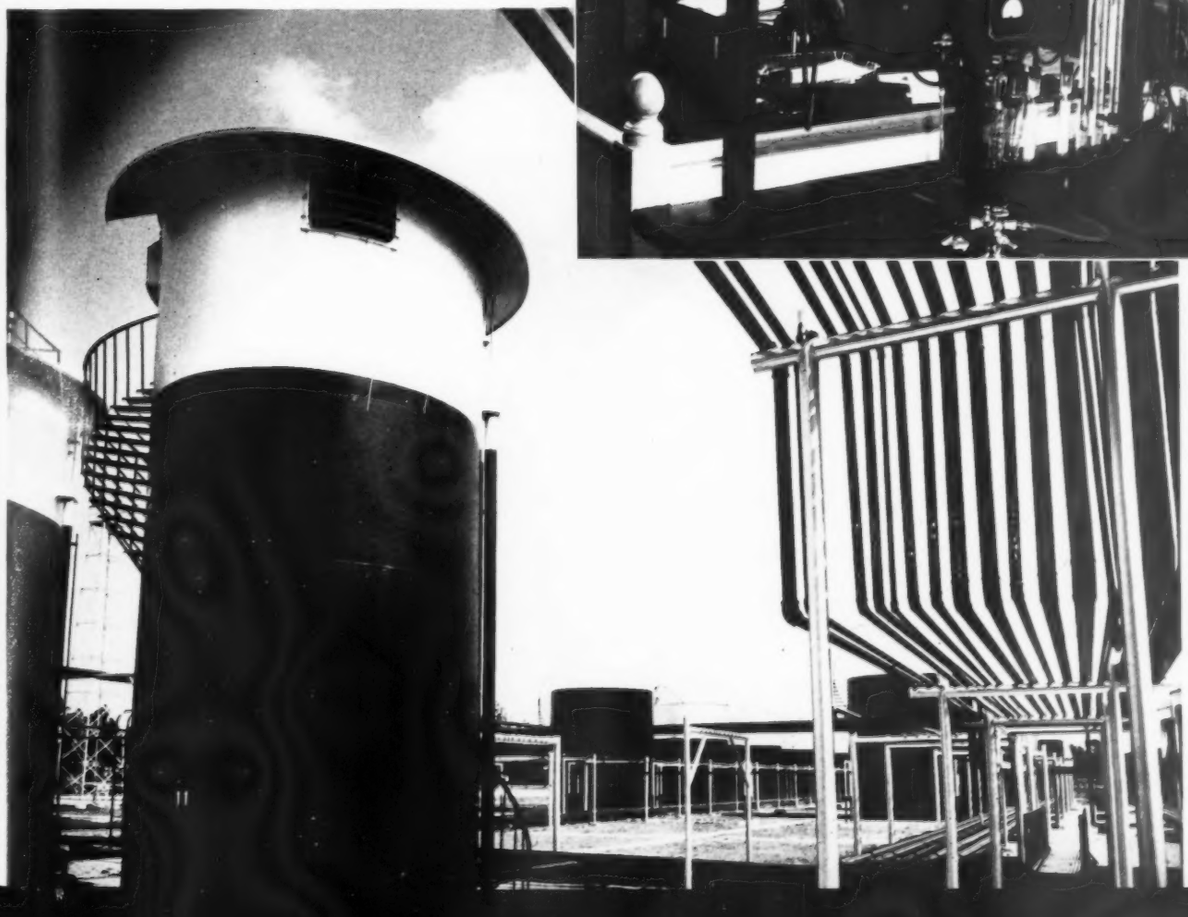
Feed stock for the polymerization plant is made up of propane and butane resulting from cracking operations and the stabilization of natural gasoline. The feed stock goes first to the polymerization feed drum, then to the furnace feed stripper, and joins with recycle as charging stock for the thermal polymerization furnace. From the furnace, the stock goes through exchangers and reboilers to the partial stabilizer tower, where polymer distillate is drawn from the base and sent to the cracking unit evaporator. Since the overhead from the partial stabilizer is principally unpolymerized propane and butane, it is passed to the furnace feed stripper where the lighter constituents are rejected overhead and the condensables join the incoming fresh feed for recycling to the furnace.

Bottoms from the depropanizer tower make up the charging stock for the alkylate reactor, which contains an emulsion compartment, an acid settling compartment, and a product-withdrawal compartment. The stock is mixed with sulphuric acid as it enters the emulsion compartment of the reactor. The reactor stock is neutralized with caustic and washed with water, sent to the iso-butane tower for removal of the iso-butane, pumped to the alkylate debutanizer for removal of the butane, and finally transferred to the alkylate rerun tower, where the light and heavy alkylates are separated and the heavy alkylate sent to the after-fractionator tower.

The plant has a daily capacity of 10,000 bbl., yields 6,000 bbl. of gasoline, and can make 600 to 1,000 bbl. of highest-octane aviation gasoline. The refinery has a storage capacity of 24,000 bbl. An unusual feature of the plant is that all pipelines connecting the processing units with storage are laid above ground, permitting regular inspection and quick repair when necessary. The plant, tank farm, and 13 houses for key employees occupy 467 pine-covered acres. Processing water for the refinery is supplied from six wells, three producing from a depth of 575 ft. and three from a depth of 275 ft. Modern water treating equipment conditions the water for boiler feed. Two 1100-h.p. boilers operate at 350 lb. pressure to provide steam power for the plant, and two 2500 kva., 2300-volt generators driven by condensing turbines provide the electric power. Cargo pumps and lines, with a capacity of 6,000 gallons a minute, run from the refinery to the water terminal on Calcasieu river, which connects with the Gulf of Mexico through Lake Charles, Lake Calcasieu, and a series of deep-water canals. Railroad loading facilities include 27 spots for 54 cars and are adequate to handle more than the present plant output.

Construction of the Louisiana refinery has brought extensive Continental marketing expansion in the Gulf Coast region. Twenty-six bulk plants and 38 service stations have recently been built by the company in Texas and Louisiana, and many more wholesale and retail outlets are contemplated. Superintendent of the refinery is J. E. Fenex, who has been supervising Continental refineries since 1928. William Cocke is assistant superintendent, Lloyd Thompson resident engineer, H. E. Luntz resident chemist and W. H. Tanner, chief clerk. Total personnel at the plant includes 106 employees.



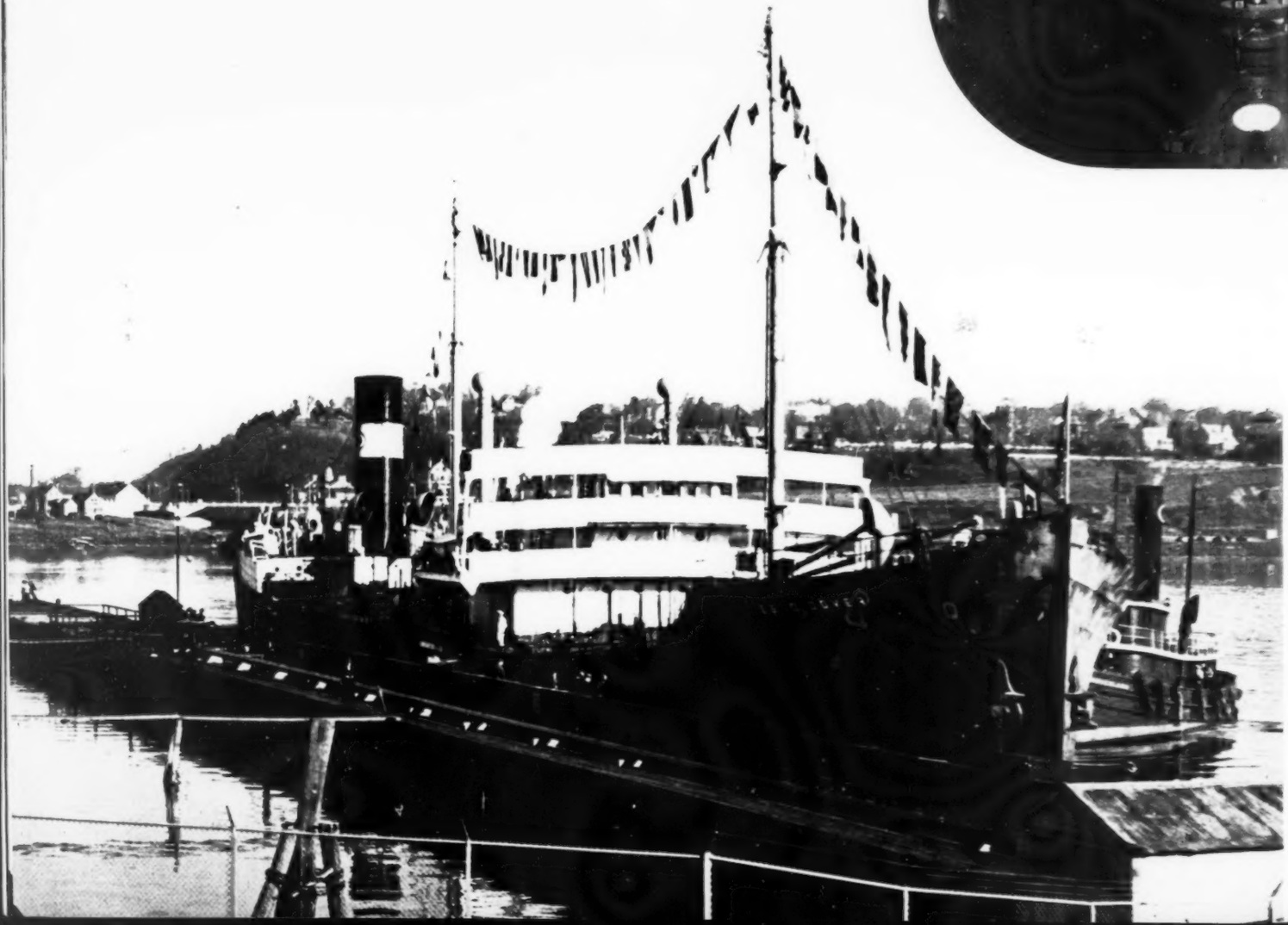


Above, H. E. Luntz with the gas analysis equipment in the laboratory: left, overhead pipelines leading from the transfer manifold with alkylation tank at left.

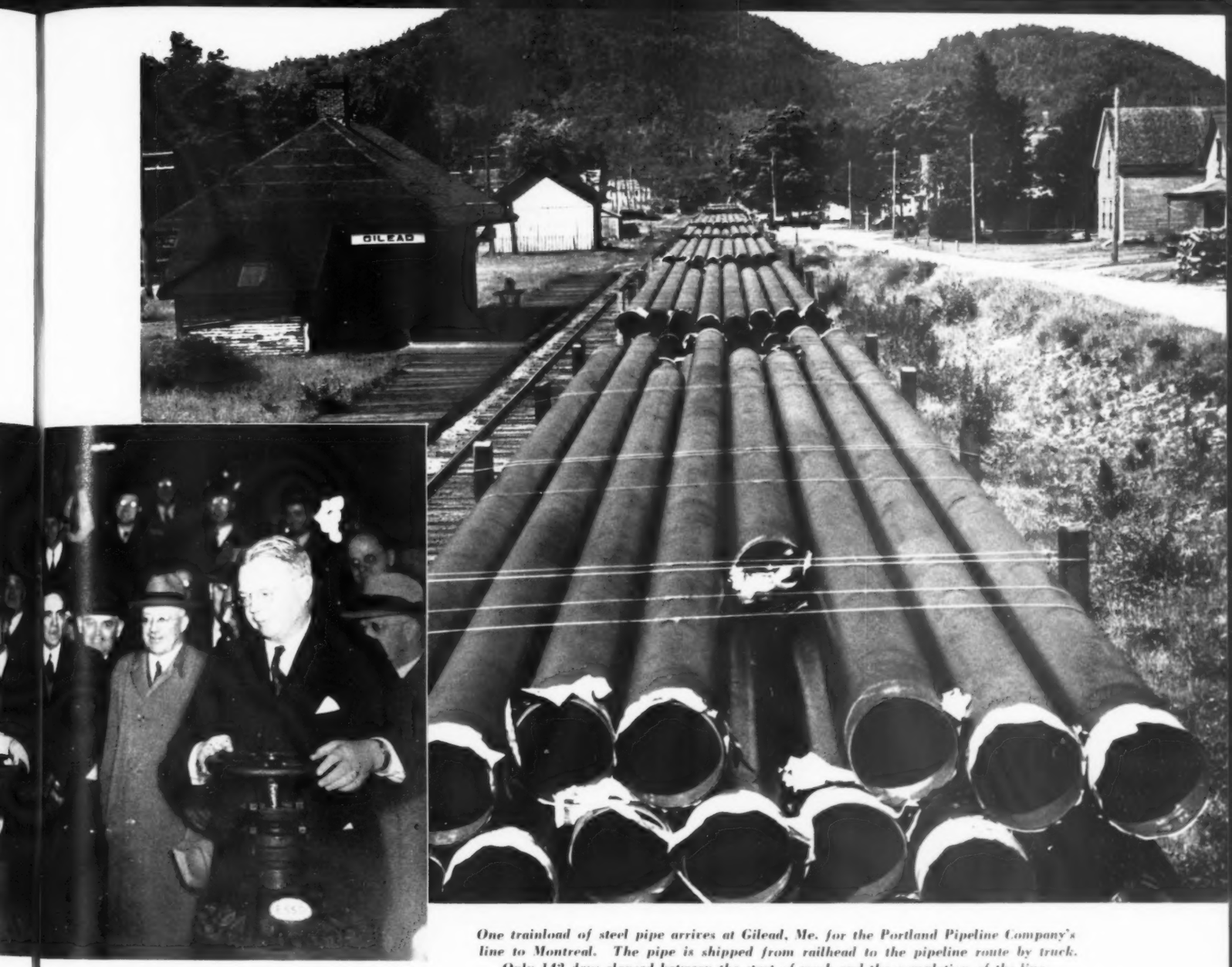
FIRST NATIONAL DEFENSE PIPE LINE IN OPERATION

Oil Begins Flow Through Portland-Montreal Duct Eliminating Two Thousand Miles of Water Journey to Feed Canadian Refineries—Construction Completed in 142 Days.

FIRST to be completed as part of the national defense program, the pipeline between Portland, Maine, and Montreal, Canada, was formally opened on November 10, exactly 142 days after the start of construction. Though only 236 miles in length the new line reduces the distance that oil must travel in transit from South America or the Gulf Coast of the United States to Montreal by some 2,000 miles and the time by ten to twelve days. It obviates the wartime risk involved in the long trip up the Atlantic Coast and through the St. Lawrence and releases a number of tankers for other service. It has a strategic advantage for Canada by making it possible to keep refineries supplied during the winter months and it enables the United States to fulfill lease-lend obligations to supply Canadian plants with crude. Though performing a public service that is highly important at this time the line was built entirely by private capital. That portion of it lying within the United



Tanker Esso Dover docking at Portland, Me. with first cargo of oil crude for shipment through the Portland-Montreal line saving the vessel a ten or twelve day trip around Nova Scotia and down the St. Lawrence.



One trainload of steel pipe arrives at Gilead, Me. for the Portland Pipeline Company's line to Montreal. The pipe is shipped from railhead to the pipeline route by truck. Only 142 days elapsed between the start of work and the completion of the line.

Gov. Sumner Sewall of Maine and A. Clark Bedford president of Colonial Beacon Oil Company turn valves to start oil flowing into the 236 mile Portland-Montreal line.

States, 164 miles in length, is owned by the Portland Pipe Line Company, while the Canadian end, 72 miles long, belongs to the Montreal Pipe Line Company, Ltd. Both are subsidiaries of Standard Oil Company (New Jersey).

Speed was the keynote of the whole construction job as it was considered essential to have it finished before the New England winter set in. Actually it was completed two weeks ahead of schedule. Aerial photography was employed in making the preliminary survey of the route followed by the line. Planes flying at an altitude of 17,000 ft. made a photographic record of a strip two miles wide extending from Portland to the international border. On this map the route was plotted and the parties making the land survey found it necessary to deviate from the line thus laid down at only a few points. Because of the restrictions on non-military flying in the Dominion, the Canadian section of the line was surveyed in the conventional manner. The aerial survey of the major portion of the line, however, effected an important saving in the time consumed in preliminary operations.

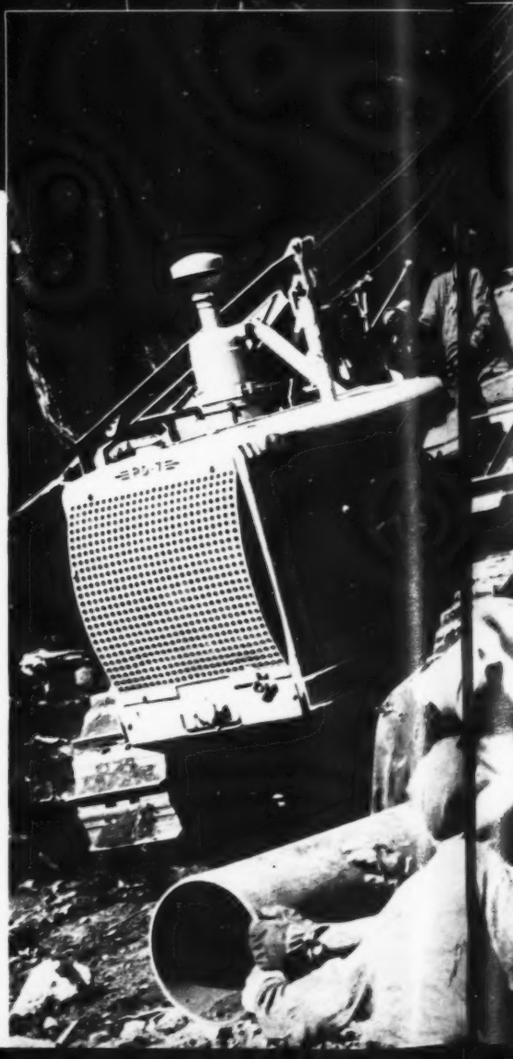
In view of the need for early completion of the line the construction work was divided into two parts. Contract for the section from Gorham, N. H. to Montreal, together with the building of all pumping stations, was let to Williams Bros. Corporation of Tulsa while the section from Gorham to Portland was undertaken by the Oklahoma Contracting Company of Dallas. Some 1,700 men were employed, including a number of experienced pipeline crews from Texas and Oklahoma, and the work was pushed forward ten hours a day and seven days a week during the period of active construction. Line was completed at an average rate of nearly two miles a day which is a remarkably good record considering the rocky character of most of the terrain. Ground was broken June 21, pipe laying began July 2 and the first batch of crude, delivered to Portland on November 3, surged into the tanks at Montreal on November 16th.

Starting from sea level at Portland the line follows a direct course northwest by west through the forested section of western Maine, then climbs gradually upward among the hills and mountains of northern New Hampshire, traversing the White Mountains through a pass and reaching its greatest elevation, 1950 ft. at Newport, Vermont, just below the Canadian boundary. From that point to Montreal the line runs through hilly country for about half the distance but as the river is approached the land flattens out to a fairly level surface. A wide variety of conditions was encountered in the work of excavation but the predominating characteristic was that of a shallow top soil with rock ledges or loose stones, many of the latter large enough to be described as boulders, underneath. Tractors, bulldozers and power shovels were used to clear the surface and remove stumps, loose rocks,

roots and similar obstacles. Trenching machines were employed wherever possible to excavate a passageway for the pipe but in many places portable compressors and air drills had to be brought into play to drill the rock for blasting, back hoes being employed to remove the shattered material. One advantage resulting from the prevalence of this type of rocky formation was that no special coating was required for the pipe on the greater part of the line, only a light priming being applied before it was placed in the trench. In the sections adjacent to the Portland terminal where salt water was encountered an asphalt and felt coating was applied and similar treatment was given to the lines underneath the St. Lawrence River and for a short distance in Canada where the route traversed an area of peat soil.

One of the interesting features in the construction of the line was the crossing of the St. Lawrence at Montreal. Instead of a single 12-in. pipe, two lines of 10-in. with a wall thickness of one-half inch were used for the river crossing. To avoid possible damage from shipping or dredging operations it was decided to excavate a channel in the river bed. The material encountered was partly silt and partly shale and trap rock. To remove the latter a submarine carrying drilling equipment put down holes along the line followed by the side walls of the projected trench. After blasting, the broken rock was removed by means of a ladder dredge. In this way the twin pipe lines were laid at a depth of 45 ft. below mean low water and from five to ten feet beneath the river bed.

Another place where the line deviates from its standard construction is the portion connecting the piers at South Portland where tankers discharge their cargoes to the tank farm about two and a half miles distance. Twenty-four inch pipe with a protective coating as previously described is used for this section of the line. Except at its two ends the line consists of pipe of 12-in. inside diameter with three-eighths inch walls, making its outside diameter 12¾ in. The pipe, supplied by Youngstown Sheet and Tube and Spang Chalfant, was delivered in 40-ft. lengths with



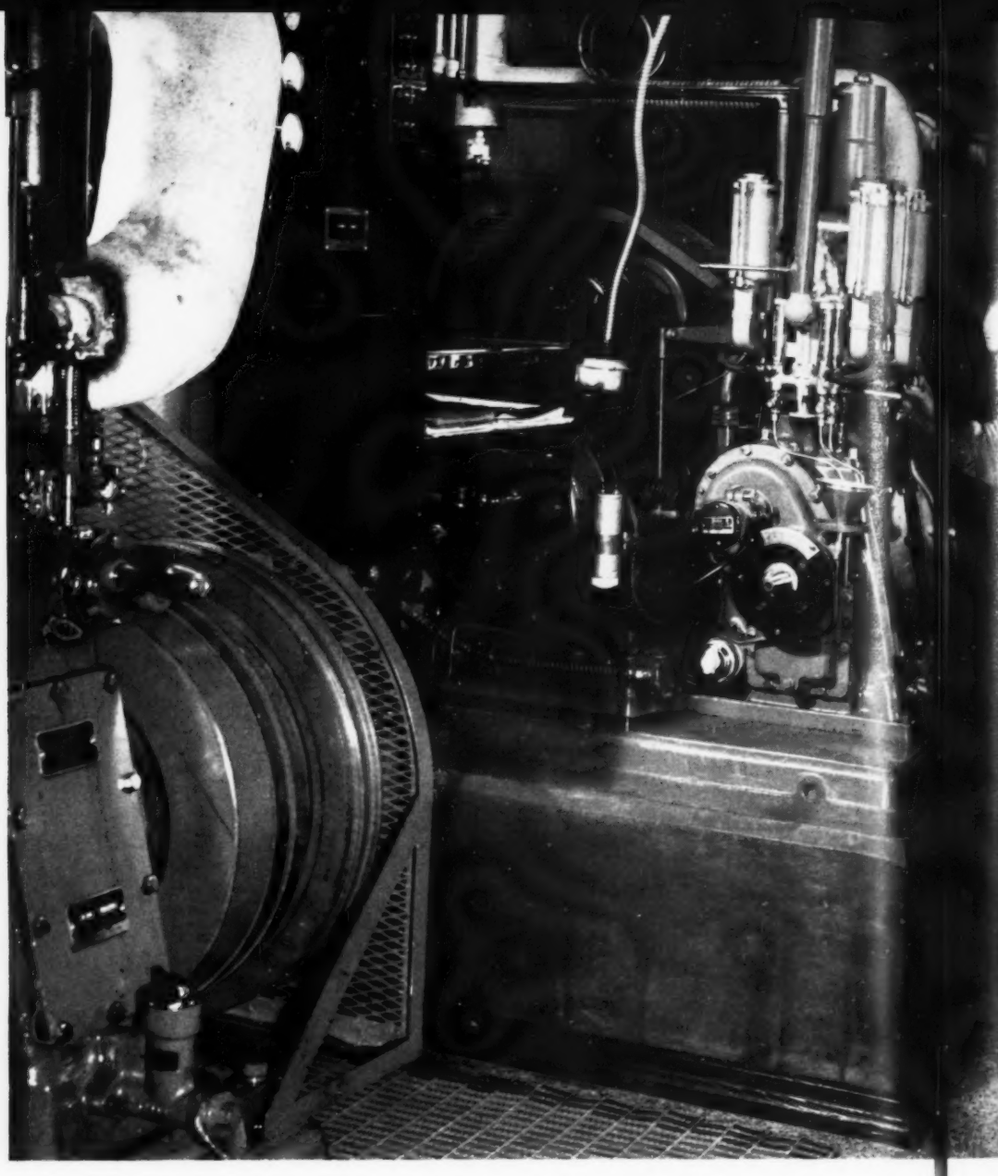
Left, welders join two of the thousands of joints in the Portland-Montreal line. Speed was the essence of the job which assures eastern Canada of crude for Montreal refineries and saves tanker space for other defense requirements. Below, though short the line passes over some rugged country. This work was pictured near Gorham in the New Hampshire mountains.

beveled ends for butt welding joints. Lincoln welding equipment was used for the welding process. The pipe weighed 49.56 lbs. per ft. and the amount of steel required for the whole line was 32,700 tons.

Eight pumping stations are located along the line; at South Portland, Raymond and North Waterford, Maine; Gorham and Riverton, New Hampshire; West Burke, Vermont; and Highwater and St. Cesaire, Quebec. Each station has two 500 hp. horizontal, triplex plunger pumps. In six of the stations the pumps are operated by electricity. The other two stations, at West Burke, Vermont, and Highwater, Quebec, are Diesel powered. The stations are about 30 miles apart and each pumping unit will receive the incoming oil at a pressure of about five pounds and step it up to 750 lbs. for the next stage of its journey. According to engineering calculations oil will travel through the line at an average rate of about three and a half miles an hour, requiring approximately three days for the full journey. The daily capacity of the line in full operation will be 60,000 bbl. At present only four of the eight pumping stations are fully equipped and some of these are using borrowed equipment so that the line now can deliver only about 30,000 bbl. per day. Each pumping station has a 30,000 bbl. storage tank.

The terminal at South Portland includes a steel and concrete pier 920 ft. in length alongside which two ocean going tankers of the largest size can discharge their cargoes simultaneously. The approaches to the pier have been dredged to a depth of 37 ft. to permit such vessels to berth on either side. Oil will be pumped from the tankers to two terminal tanks with a capacity of 140,000 bbl. each and a vessel carrying sufficient oil to fill one of these tanks will require about 20 hours to unload. From the pier terminal the oil is transferred by four 100 hp. pumps to the 34 acre tank farm which contains the main storage plant. This consists of four tanks of the floating roof type, 144 ft. in diameter and 48 ft. high, each with a capacity of 140,000 bbl. At the Canadian end of the line, at Boucherville on the south bank of the St. Lawrence, a manifold station will direct the oil through one or the other of the twin pipes leading beneath the river to the opposite shore.

The Portland-Montreal line ordinarily will be fed with crude brought from South America. The first cargo of 103,000 bbl., from Coveñas, Colombia, arrived at Portland on November 3 aboard the tanker Esso Dover and was the first oil to travel through the line, reaching Montreal November 16. It is expected that two tankers weekly discharging at Portland will be able to supply the line on its present scale of operation. No difficulty is anticipated in the operation of the line during the extremely cold winter weather of northern New England and Canada. The crude oil that passes through the line comes from South America and is loaded into tankers at a temperature of 80 to 90 deg. F.



NEW LIGHT

ON SELECTIVE BLENDING

By Dr. O. W. Wilcox

At the present time, and undoubtedly for all time, it is required of a marketable motor gasoline that it shall have a satisfactory knock rating, which is supposed to mean that it shall have a satisfactory octane number. In determining what the octane number of his gasoline shall be, the petroleum refiner has to consider the matter from two different angles. First, it must perform satisfactorily in the current types of automobile engines. Beyond that, the refiner must try to give it an octane number that will at least be on a par with the octane numbers of competing gasolines. This latter requirement arises out of the fact that octane number has become a talking point in the gasoline market. For some time the refiners have been engaged in an octane race in which each goes as far as he can to raise the octane number of his product, with the result that many if not most, well advertised brands have more octanes than is perhaps strictly necessary for present-day automobiles.

Nearly all gasolines are blends of various petroleum products. In making these blends the

Constant research is required to determine the effects of various blends on improving motor fuels in some respects without inhibiting other desirable characteristics.

idea is to mix products that have low octane numbers with other products that have high octane numbers. The proportions of the ingredients are chosen so that the octane number of the mixture will be about what is required. Generally the aim is to bring the octane number of the mixture somewhat near the market standard, and then to complete the operation by adding the fewest cc. of tetraethyl lead that will bring the mixture up to the market requirement. The making of a mixed gasoline that will have a specified octane number would be simplicity itself if the octane numbers of the ingredients were additive. In that case a mixture of equal parts of one product with an octane number of 50 and another product with an octane number of 100 would give a mixed gasoline having an octane rating of 75. This will be approximately the case when the components have similar compositions. Mixtures of natural gasolines, or of stocks made from crudes that are not too different from one another, or gasolines cracked by the same process, may generally be expected to have additive octanes. The one blending agent that seems to blend normally with most other gasoline stocks is iso-octane. As a general rule, however, the blending of materials having different compositions results in blends that may have higher or lower octane numbers than would be expected from the octane-numbers of the components and the proportions of mixing. In other words, the blending agent appears to have a different anti-knock value in mixtures than it has in the pure state. Some polymer gasolines, taken by themselves, have octane numbers of around 80, but when blended with 45 o.n. straight run gasoline they act as though they had an octane blending value of more than 100. On the other hand, some aromatic hydrocarbons that have high anti-knock value in the pure state lose some of it when blended with various base stocks. The number of such complexities is great, and the greater the difference between the octane numbers of the stock and the blending agent, the more unpredictable the octane number of the blend. Further complexity is added by the fact that the same blending agent, added to the same stock, will give mixtures of different octane numbers according to the proportions used. From all of which it results that the blending of octanes is largely purely empirical and seems not to be reducible to fixed rules in spite of numerous attempts to set up mathematical formulas. When the refiner has learned the properties of materials of the same kinds the matter is simple, but when unknown materials come into use their properties have to be learned by trial and error.

As if all this were not confusing and uncertain enough, there is the fact that when two blended gasolines are made so that they will show the same octane number during a test by the same laboratory engine, when, taken out on the road for a practical test it may and often does turn out that they differ markedly in their road anti-knock performance. The upshot is that the refiner needs both a rule for mixing gasolines to a desired octane number, and another rule that will tell him what anti-knock performance his product will show on the road. The sad fact is that there is no significant correlation between road performance and motor and research octane numbers of the fuel. When and if it becomes known what factors control the road anti-knock performance of an automobile fuel it will then become the object of the refiner to blend so as to provide these factors; the actual laboratory octane number would then become more or less conventional but without decisive significance. This would also be in a measure true of aviation gasolines. Recently there has been some significant progress along this line. The progress here referred to is divisible into two parts, one following upon the other.

The first item relates to progress in a method for rating gasolines by a road test. Automotive engineers and petroleum technologists have known for many years that there is a marked difference in the road anti-knock performance of different types of gasolines. Perhaps the most outstanding example is the difference between a vapor-phase cracked gasoline and a straight run gasoline of the same motor method octane number. When these gasolines are tested by the standard CFR road-test procedure (Uniontown, 1932) the vapor-phase cracked gasoline knocks more severely at high speeds than the straight run gasoline, which in turn knocks most severely at low speeds. Observation of this circumstance finally led to a feeling that the standard CFR road test procedure was not telling the whole

story. This procedure rates a fuel solely on the basis of maximum knock intensity in the speed range wherein this knock occurs and gives no indication of the road performance of a fuel at speeds at which no knock occurs. To overcome this defect of the standard CFR procedure, a new procedure, known as the border-line test method, has been developed by Campbell, Greenshields and Holoday out of the 1940 road tests of the Cooperative Fuel Research Committee. This method is designed to give a graphical idea of a fuel's ability to tolerate spark-advance throughout the engine-speed range. As the name implies it represents the knock-die-out point between satisfactory and unsatisfactory operation; i. e., between knocking and non-knocking operation. The border-line test method is particularly adapted to bring out the differences between the vapor-phase cracked and the straight run gasolines, the two extreme types referred to above. By this method it is seen that the former gasoline type has extremely good high-speed anti-knock qualities. Obviously, if the good qualities of these two fuels could be combined the result would be a highly satisfactory fuel that would not knock at any speed or spark setting.

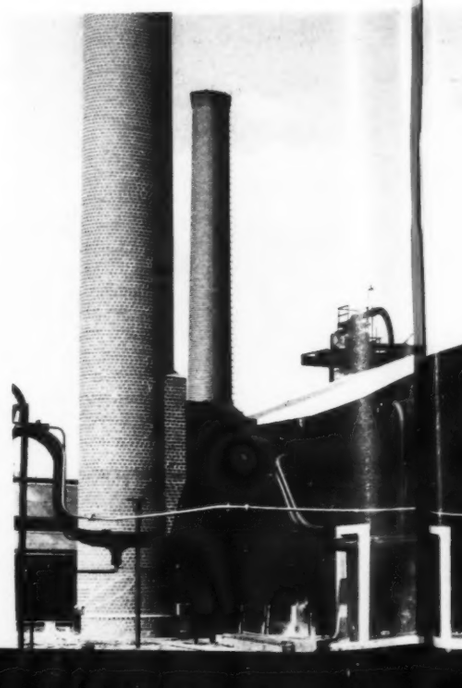
From this point the second item of progress toward understanding road knock performance took its origin. Since the chief difference between a vapor-phase cracked gasoline (rich in olefins, aromatics, etc.) and a straight run gasoline (consisting nearly exclusively of paraffins) lies in the natures of the components of these fuels, it was evident that the border-line test method would differentiate between fuels of different chemical compositions. Following up this idea in a research reported at the November, 1941 meeting of the American Petroleum Institute. Wagner, Ross, Henderson and Risk had their attention drawn to previous work which indicated that fuels having their high-octane material concentrated in the heavy end, were depreciated in comparison with similar fuels having high-octane material concentrated in the light end. This was a further indication of the influence of chemical composition of a gasoline on its road anti-knock performance, and the correctness of the inference was confirmed by a simple experiment. A blended gasoline was made up with mixed amylenes as the high octane material (octane number of the mixed amylenes was about 125). The border-line tests of this fuel showed a low-speed anti-knock improvement which was remarkable in contrast with similar experiments using other high-octane materials in the light fractions. This raised the question as to why the amylenes should be so much better. It turned out that all the high-octane blending agents used in these experiments had been paraffinic (isopentane) rather than olefinic in nature. At about this stage of their investigations Messrs. Wagner and associates formulated their definitions of the ideal automotive fuel, based on road behavior. It is a fuel that will not knock at any speed of the engine in which it may be used. Neither a vapor-phase cracked gasoline which has low-speed anti-knock quality but knocks most severely at high speeds, nor a straight run gasoline which has good high speed anti-knock value but knocks most severely at low speeds will qualify as an ideal fuel under this definition.

This preliminary work showed that some sort of selective blending of straight run and cracked stocks should be employed to produce a fuel which would more nearly conform with the definition of the ideal fuel. It turned out that a 50:50 blend of the fuel-boiling-range stocks was not the answer; such a blend was found to produce a rather average fuel, not as good at low speeds as the cracked gasoline, and not as good at high speeds as the straight run gasoline. Recalling the tests that showed the superiority of light olefine material as a booster of low-speed anti-knock performance, it was suggested that perhaps by fractionating and blending it might be possible to combine the good qualities of both straight run and vapor-phase cracked gasolines. The proposition was clinched by the following experiment: a highly cracked fuel was cut into two equal portions by distillation. To the light fraction a heavy paraffinic stock was added to make a fuel which may be called A. In contrast to this, a light saturated fraction was added to the heavy cracked material to constitute a fuel B. The result was that by selectively blending the light cracked fractions with the heavy straight run material, the good low-speed characteristics of the highly cracked fuel were retained, and at the same time there was a noticeable improvement in its high-speed performance. These results gave the first definite indication that it might be possible to improve motor fuels considerably by blending narrow cuts rather than full-boiling-range stocks. The investigators see in this a hint for someone to devise a new refinery process which will yield directly a motor fuel having this desired composition. No doubt research in this direction has already been started.

However, it is recommended that the refiner consider not only the road anti-knock qualities of the base gasoline, but also its response to tetraethyl lead, because most refiners use lead to obtain and maintain the proper anti-knock level of their commercial products. Having established the octane level of a given product, it is essential that the leaded fuel rather than the base fuel itself should conform to the definition of the ideal fuel. Experiments show that the addition of lead to the average base stock has a tendency to increase the high-speed anti-knock performance to a greater extent than the low-speed performance. Apparently, then, if the ideal fuel is to contain lead, the base stock should have low-speed anti-knock qualities such that when lead is added the borderline curve of the fuel will take the proper shape in relation to the spark-advance requirements of the engine. Out of this comes the suggestion that perhaps the ideal fuel should be made by adding both unsaturated material and tetraethyl lead to the base stock; this, however, imposes the necessity of taking account of the lead susceptibility of any base fuels that might come into consideration.

In the light of the definition of the ideal fuel, which was suggested by experience with the borderline method of road testing, it became of interest to determine to what extent commercial gasolines conformed to the ideal requirement, which is that the gasoline should not knock at any speed of the engine in which it is used. A survey was accordingly made of about 200 commercial motor fuels comprising some 15 different brands; these were tested in 25 different cars. The survey indicated that the average fuel tends to knock at low speeds, although its high-speed performance is usually adequate. From this it seems to be evident that an improvement in the low-speed anti-knock characteristics of commercial fuels is desirable. How is this improvement of commercial fuels to be brought about? The experimental work that has been accomplished on the blending of selected stocks indicates that the nearest approach to the ideal will be a fuel in which the volatile fractions are composed largely of high-octane olefinic material and the heavy fractions largely composed of saturated hydrocarbons. However, it is not clear that the refining industry can proceed with the commercial production of such a fuel without considerable changes in refinery equipment, or perhaps the development of entirely new refining processes. There is, of course, the possibility that some of the newer existing processes, such as catalytic cracking and catalytic reforming, alone or in proper combination, may produce fuels which will meet these requirements with little or no change in equipment, except, perhaps, the addition of a few specialized units.

Behind this proposition to prepare for the manufacture of improved motor fuels there seems to loom the spectre of obsolescence. Suppose that the refiner adds special equipment that will turn out a fuel that will be ideal for the current type of automobile engine, only to find that the engine manufacturers have stepped up their compression ratios, thus compelling the refiner to furnish gasolines of higher anti-knock value. In taking account of this possibility, Wagner, Ross,



Henderson and Risk have carried out experiments which confirm previous results that an improved motor fuel can be prepared by blending selected cuts rather than full-boiling range stocks. This has been proved to be a valid possibility for producing the fuels of the future, because this type of blending is independent of the octane value of the fuels or the compression ratio of the engines. These experiments further indicated that it is most important to use unsaturated material in the light fractions, but that the composition of the heavy fractions may vary considerably. They also carried the suggestion that the heavy blending stock need not be necessarily paraffinic in nature, but might consist of alkylated aromatics or naphthenes with approximately the same results. If this were true, it would increase the commercial practicability of such selective blending. There was also some indication that if a small amount (10 or 15 percent) of the high boiling olefins in a highly unsaturated type of fuel were replaced by high-boiling paraffinic material, a much improved product would be obtained. This suggestion was also put to an experimental test, and the experiments had this result: paraffinic material is preferable as a heavy blending agent, but either aromatic material or naphthenic material would be a satisfactory substitute in the order named. The differences between these three types of high-boiling materials become more apparent if evaluated in terms of their relative effect on the road lead susceptibility of the blends. The fuel containing the heavy paraffinic material has the best road lead susceptibility in both the low-speed and the high-speed range. The fuel containing aromatic heavy ends has relatively good high-speed lead response, but approximately the same response at low speeds as that of the fuel containing heavy naphthenic material. This again emphasizes the fact that the chemical composition of the high-boiling fractions may have a noticeable influence on the low-speed lead susceptibility of a gasoline.

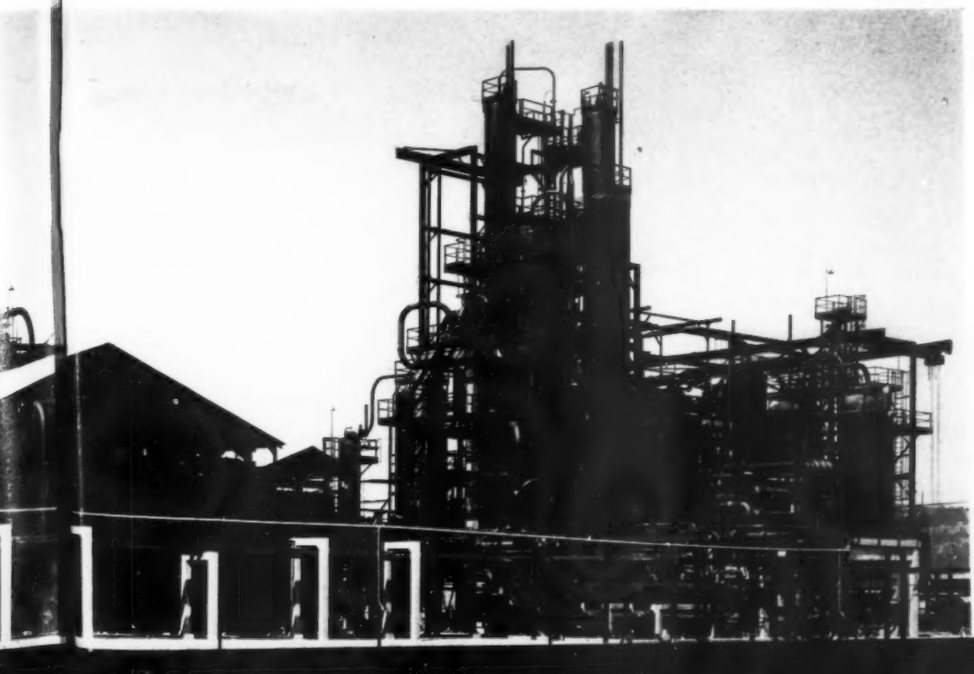
It is inevitable that the average refiner will view this matter from the standpoint of refinery economics. Commercial fuels cannot be made by cutting up present fuels, using the desirable portions and throwing the rest away. If the principles of selective blending here established are to be applied to full-scale refinery operation, some means must be found for utilizing all of the fractions of all of the refinery stocks in the finished gasoline. But the principles are there, and it is up to the refiner to take what advantage of them he can. As one indication of what might be done, an example will here be quoted from the paper of Wagner and associates. One gasoline (E-5) was prepared by selective blending. Another (E-6) was taken to represent present commercial production.

Fuel No.	Description
E-5	**50 percent of a blend of high-pressure catalytically cracked gasoline and catalytically dehydrogenated light straight run gasoline; boiling range up to 275 deg. F. 50 percent of catalytically reformed heavy cracked and heavy straight run gasolines; approximate boiling range 250 deg.-400 deg. F.**
E-6	**Regular commercial combination high-pressure unit production from Illinois charging stock, approximately: 30 percent of 325 deg. F. end-point straight run gasoline, and 70 per cent of cracked and reformed gasolines.**

A comparison between the road anti-knock performance, and especially the road lead susceptibility of these fuels indicates that a reasonable increase in the cost of production could well be tolerated to produce such a fuel as E-5. It is highly probable that more extended research will lead to even better results. The field that has now been opened up is undoubtedly a wide and fertile one leading to improved motor fuel.

In general these researches have indicated four broad precepts for improving average fuels by altering their composition in ways that will cause them to approach the composition of the ideal fuel: (1) By the substitution, in small amounts, of high-boiling paraffinic, aromatic or naphthenic material for the high-boiling olefinic hydrocarbons normally contained in a highly cracked fuel. (2) By the addition of light olefinic or aromatic material to a straight run fuel. (3) By blending refinery stocks with due consideration of the effect of such blending on the lead susceptibility throughout the speed range. (4) By using light olefinic material rather than light paraffinic material to obtain satisfactory volatility.

It may be remarked again that the foregoing relates to the blending of commercial automobile fuels. At the present writing the interest of the oil refining industry is largely centered on the blending of gasolines to produce 100 octane number aviation fuel. The blending materials that may be used for this purpose are well known and have been expressly reserved for this use, and so have been put out of reach of the makers of ordinary gasolines. The blending agents thus reserved are, among others, iso-octanes, including alkylates, hot acid octanes and hydrocodimers, iso-pentanes and neo-hexanes. While it is well known that these materials when added to a base stock of sufficiently high quality and treated with tetraethyl lead, will give 100 octane number aviation gasoline, little is known of their relative behavior as components of an ideal fuel as defined by Messrs. Wagner and associates. Undoubtedly the principles of selective blending that apply to blending automobile gasolines will apply also to the blending of aviation fuels. Here is opened a large field for research of much significance, and the oil refining industry will undoubtedly be interested in having these ideas followed through.



Naphtha polyform unit of the Gulf Oil Corporation source of one type of material for selective blending to produce high octane fuels.

C. J. Coberly

C. J. Coberly Elected Director of Consolidated Steel Corporation, Ltd.

CLARENCE J. COBERLY, President of Kobe, Inc., was elected a Director of Consolidated Steel Corporation, Ltd., at its recent meeting of the Board of Directors, held October 31. Mr. Coberly will fill the vacancy which occurred on the death of Donald G. Henderson. Mr. Coberly, long prominent in the engineering field, is well known to Southern California business men. He is a member of the A.S.M.E., A.I.M.E., the A.P.I., the Los Angeles Athletic Club, the California Club, the University Club, and the Los Angeles Yacht Club.

FOREIGN OIL LEGION

H. B. Heath-Eaves, deputy chairman, Anglo-Iranian Oil Company.

J. A. Thomas, president of the New York Chapter of Nomads presenting a certificate of honorary membership to B. A. Meyers, director of International Petroleum Company while Russell Heath looks on. Mr. Meyers is the first honorary member of the N. Y. chapter. The presentation took place during a luncheon at the Waldorf on November 12.

Members of the Association of Well Head Equipment Manufacturers at the regular monthly meeting in Fort Worth, October 14. Seated, left to right: E. L. Barker, L. D. Hilton, E. L. Lorehn, G. S. Watson, L. L. Rector and B. V. Fisher. Standing, left to right: Charles Zartman, C. L. Cron, John H. Moran, J. J. Hastik, Frank Crow, L. L. McColum, C. J. Harris, M. T. Works, Roy Hammond, A. Henderson, and R. V. Evridge.

MARKING what is destined to be the first of a series of annual cocktail parties the California Nomads entertained visiting members from New York, Houston and Tulsa Chapters during the A.P.I. Convention in San Francisco, the evening of November 5th. The affair, a combination buffet supper and cocktail party, was held from 5:00 to 8:00 p.m. at the San Francisco Stock Exchange Club. Strictly invitational and originally planned for 300 guests, it broke all records with a total attendance of 389. In addition to nearly 100 California Nomads and ladies, between 30 and 40 foreign oil men, together with various A.P.I. officials and prominent oil company executives were among those present.

J. C. Axelson left and Alvin Zwerneman at the Nomads cocktail party.

Nomads H. M. Cosgrove, Milton Lewis, Bob Nagel and Elmer Decker.

H. B. HEATH-EAVES, director of the Anglo-Iranian Oil Company, Ltd., has been appointed deputy chairman. Mr. Heath-Eaves spent his early days in Burma and India with the Burma Oil Company, becoming general manager for India. Later he transferred to the Anglo-Iranian, and served as general manager of the company's Persian operations from 1914 to 1921. In the latter year he returned to London as a member of the executive staff of Anglo-Iranian and was made a director of the company in 1924. In 1938 he spent some time in the United States as the company's American representative. Since the beginning of the war he has served as chairman of the British Tanker Tonnage Committee, a post of great responsibility that has occupied most of his time.

Nomads Party in San Francisco

M. T. Works, J. M. O'Melveny, E. W. Farrow, Kenneth Carver, Gustav Egloff, A. Levy, E. W. Leonardon, Robert Henquet and Ray Dudley.

Mr. & Mrs. A. V. Simonson, J. Zunino, S. J. Gallay, Rex Hamaker and George Wood.

M. E. Montrose, E. A. Eddleman, Morton Higgs, S. H. Witheston, L. L. Rector and Ted Sutter.

James McPhee, Dave Anderson, Bill Eggleston, H. D. Aggers, S. H. Grinnell, J. McNeil, Bart Gillespie and Hi Cassidy.

John Peat, Rodney Durkee, George Radcliffe, M. L. Dorn, Mrs. Dorn and Mrs. Rodney Durkee.

W. McGarry, Frank Holloway, S. C. Hamilton, Frank V. Long and J. M. Greenlee.

N. W. Wickersham, R. J. Retner, J. C. Axelson and A. Zwerneman.

Larry Miller, Ernie Foucks and Kinzey Miller.

Jack Ballagh, Hal Marsh, Paul Jones and M. L. Dorn.

E. W. Farrow, Rex Hamaker, W. L. Childs and N. R. Crawford.

A. G. Fisk, H. M. Van Clief, E. W. Farrow and Pete Maxfield.

Hi Cassidy, L. P. St. Clair and Rodney Durkee.

WORLD OIL PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

U. S. BARRELS

	October 1941 Preliminary	October 1940	Jan.-Oct. 1941	Jan.-Oct. 1940
United States	126,724,900	113,418,000	1,153,538,900	1,139,425,500
Soviet Union	18,048,000	19,608,000	190,831,000	203,316,000
Venezuela	21,181,575	13,828,100	179,353,354	158,328,764
Iran	6,596,084	6,700,000	65,055,676	65,891,675
Netherlands India: Sumatra	3,500,000	3,345,000	33,940,060	33,896,986
Borneo	1,240,000	1,070,400	11,407,720	10,846,799
Java	594,000	537,600	5,565,960	5,502,262
Molucca and Other	62,000	60,300	598,780	611,146
Rumania	3,000,000	3,063,725	30,122,120	36,408,042
Mexico	2,821,000	3,472,000	29,069,000	33,474,787
Iraq	800,000	1,000,000	8,300,000	22,225,067
Colombia	2,073,382	2,192,000	19,979,568	22,066,890
Trinidad	1,800,000	1,800,000	17,668,840	16,618,566
Argentina	1,840,000	1,795,564	18,020,592	16,975,793
Peru	1,147,000	1,025,000	10,588,520	10,985,324
Bahrein	635,000	393,634	6,062,000	5,882,775
Burma	660,000	610,114	6,533,490	6,510,673
Canada	843,820	817,596	8,274,995	7,086,161
Brunei	465,000	472,200	4,636,743	4,784,774
Great Germany: Old Reich	370,000	380,000	3,709,612	3,983,959
Ostmark	58,000	59,200	578,109	560,094
Slovakia & Moravia	9,000	9,800	91,430	99,175
Poland	232,500	320,700	2,861,400	3,250,056
Japan	227,300	217,470	2,212,000	2,203,704
British India	194,000	185,400	1,886,916	1,879,021
Ecuador	104,615	226,142	1,219,564	2,080,223
Saudi Arabia	520,000	467,900	4,849,440	4,428,810
Sarawak	112,000	108,700	1,091,640	1,101,185
Egypt	650,000	575,000	6,379,640	4,753,367
Italian Empire: Albania	115,000	135,000	1,155,000	1,227,124
Italy	3,800	4,000	38,574	49,350
France	41,000	41,000	397,922	416,498
Hungary	227,300	180,000	2,026,300	1,395,000
Bolivia	10,000	10,000	101,106	90,484
Other Countries	49,500	47,800	483,370	484,397
WORLD TOTAL	196,919,776	178,177,345	1,828,608,341	1,828,840,371

METRIC TONS

	October 1941 Preliminary	October 1940	Jan.-Oct. 1941	Jan.-Oct. 1940
United States	17,145,839	15,345,420	156,073,453	153,487,471
Soviet Union	2,475,720	3,000,000	26,174,207	28,200,000
Venezuela	3,145,000	2,053,170	26,749,301	23,508,354
Iran	861,220	874,787	8,530,539	8,698,759
Netherlands India: Sumatra	448,086	426,300	4,343,273	4,319,609
Borneo	158,750	137,000	1,460,448	1,388,718
Java	76,046	69,200	712,961	698,582
Molucca and Other	7,937	7,700	76,764	78,169
Rumania	406,779	415,420	4,084,354	4,927,684
Mexico	414,243	509,838	4,268,590	4,838,990
Iraq	106,937	133,672	1,109,449	2,971,534
Colombia	284,153	305,718	2,639,185	3,077,664
Trinidad	253,164	253,165	2,485,067	2,336,588
Argentina	262,108	255,778	2,565,613	2,425,324
Peru	151,419	135,313	1,397,722	1,452,169
Bahrein	86,651	53,766	827,209	812,973
Burma	91,160	84,408	902,085	899,079
Canada	107,383	104,046	1,045,853	901,769
Brunei	61,055	62,970	614,632	638,066
Great Germany: Old Reich	52,910	54,340	530,497	542,910
Ostmark	8,646	9,390	86,190	95,265
Slovakia & Moravia	1,326	1,470	13,477	14,984
Poland	31,338	43,000	385,674	434,984
Japan	32,332	31,000	314,645	314,657
British India	26,795	25,600	260,623	259,386
Ecuador	13,791	29,814	160,780	274,250
Saudi Arabia	70,960	63,400	659,982	599,985
Sarawak	14,088	14,000	138,536	141,735
Egypt	92,830	82,119	911,139	678,854
Italian Empire: Albania	17,236	20,233	173,113	183,733
Italy	472	500	4,797	6,110
France	5,751	5,760	55,812	58,368
Hungary	30,379	24,200	272,617	187,625
Bolivia	1,296	1,400	13,244	11,449
Other Countries	7,071	6,800	68,963	69,179
WORLD TOTAL	26,951,073	24,640,697	250,110,794	249,534,888

Official Crude Oil Production Figures from 1938 to 1940

	Daily Averages Bbl.		Daily Averages Metric Tons		Total Bbl.			Total Metric Tons		
	Jan.-Oct. 1941	Jan. Oct. 1940	Jan.-Oct. 1941	Jan.-Oct. 1940	1940	1939	1938	1940	1939	1938
United States	3,794,535	3,735,821	513,399	503,237	1,351,849,500	1,264,962,000	1,214,355,000	182,904,869	171,152,192	164,346,325
Soviet Union	627,664	666,098	86,099	92,217	220,600,000	220,866,000	219,194,000	30,260,631	30,297,119	30,067,764
Venezuela	589,978	519,110	87,991	77,076	184,761,241	205,783,650	188,429,050	27,432,998	30,533,706	27,845,286
Iran	213,998	216,382	28,061	28,446	79,151,675	78,151,332	78,320,840	10,443,546	10,367,117	10,358,495
Netherlands India: Sumatra	111,644	111,376	14,287	14,162	40,586,986	41,557,013	34,538,128	5,172,209	5,320,320	4,662,836
Borneo	37,525	35,563	4,804	4,553	12,987,599	13,125,425	12,812,383	1,662,718	1,680,377	1,719,783
Java	18,309	18,040	2,345	2,290	6,514,462	6,568,714	6,955,283	836,982	842,237	933,595
Molucca and Other	1,969	2,003	252	256	731,746	836,144	607,622	93,569	107,047	81,560
Rumania	99,086	119,370	13,435	16,156	42,524,988	46,020,000	48,366,000	5,766,099	6,240,000	6,603,000
Mexico	95,621	109,753	14,041	15,865	40,314,787	39,428,141	38,505,824	5,843,395	5,794,035	5,716,423
Iraq	27,302	72,868	3,649	9,742	24,225,007	30,791,132	32,404,000	3,238,878	4,115,845	4,345,000
Colombia	65,722	72,350	8,681	10,090	25,592,890	23,857,000	21,581,588	3,569,434	3,327,336	3,007,935
Trinidad	58,121	54,487	8,174	7,661	20,218,566	19,270,256	17,736,176	2,842,918	2,710,515	2,472,943
Argentina	59,278	55,658	8,439	7,952	20,616,928	18,738,003	17,076,237	2,936,880	2,657,232	2,432,857
Peru	34,830	36,017	4,597	4,761	12,985,284	13,587,906	15,908,279	1,716,195	1,798,557	2,099,885
Bahrein	19,940	19,287	2,721	2,665	7,095,370	7,588,554	8,297,998	968,502	1,045,391	1,130,734
Burma	21,491	21,346	2,967	2,947	7,730,901	7,872,981	7,499,498	1,067,895	1,087,424	1,039,960
Canada	27,220	23,233	3,440	2,956	8,718,053	7,837,503	6,965,457	1,109,440	997,487	879,921
Brunei	15,252	15,687	2,021	2,092	5,729,374	5,767,227	5,387,214	764,006	768,320	707,123
Great Germany: Old Reich	12,202	13,062	1,745	1,780	4,543,954	4,487,491	3,850,044	653,590	647,337	552,074
Ostmark	1,901	1,836	283	312	718,494	693,247	370,038	114,045	109,900	63,468
Slovakia and Moravia	301	325	44	48	118,775	119,380	132,005	17,836	18,103	19,282
Poland	9,412	10,656	1,268	1,426	3,891,456	3,898,044	3,828,438	520,984	522,874	504,678
Japan	7,276	7,225	1,035	1,031	2,638,644	2,652,930	2,511,184	376,657	379,161	356,328
British India	6,207	6,160	857	850	2,249,835	2,332,467	2,330,209	310,596	322,160	322,125
Ecuador	4,011	6,820	528	899	2,349,015	2,312,118	2,257,278	309,686	306,824	319,877
Saudi Arabia	15,952	14,520	2,170	1,967	5,364,610	3,933,904	495,135	726,785	536,366	66,683
Sarawak	3,590	3,610	455	464	1,317,185	1,329,645	1,624,882	168,475	171,322	200,126
Egypt	20,985	15,581	2,997	2,225	6,053,367	4,603,797	1,561,231	864,514	657,570	223,058
Italian Empire: Albania	3,799	4,023	569	602	1,497,124	1,393,727	437,597	224,199	208,279	65,313
Italy	127	161	15	20	57,350	91,330	106,083	7,110	11,346	13,178
France	1,309	1,365	183	191	496,420	500,815	516,240	69,578	70,478	72,106
Hungary	6,665	4,573	896	615	1,755,000	815,248	330,829	236,025	109,896	42,798
Bolivia	332	296	43	37	110,484	100,885	106,620	14,249	11,998	13,262
Other Countries	1,590	1,588	226	226	579,997	578,036	243,000	82,779	82,300	34,080
WORLD TOTAL	6,015,144	5,996,250	822,717	817,817	2,148,677,067	2,082,452,045	1,995,611,390	293,328,272	284,908,175	280,319,861

Detailed monthly reports were published in February, 1941 issue.

BOYD ELECTED PRESIDENT OF A.P.I.

WILLIAM RUFUS BOYD, JR. has been elected ninth president of the American Petroleum Institute. His connection with this organization dates practically from its beginning directly after the first World War and his activity in behalf of the A.P.I. has been an important influence in its growth and development. Born in Texas, Mr. Boyd studied law and was admitted to the Texas bar at the age of 19, later becoming secretary to Congressman Scott Field. Mr. Boyd spent two years in Washington before returning to Texas to begin the practice of law at Teague and to become that town's first mayor. For the past twelve years Mr. Boyd has been the executive secretary of the Institute and probably is personally acquainted with more oil men than any other individual in the United States. He is 59 years old, is married and has one son.

W. R. Boyd Jr. president of the American Petroleum Institute

CORRECTION

THE patent referred to in the article beginning on page 70 of the 1941 Annual Refinery issue of WORLD PETROLEUM entitled "Refiners to Concentrate on 100-Octane" as "Monnell's U. S. Patent No. 2,169,809 of August 15, 1939," which covers the alkylation process for the production of high octane aviation gasoline should read "Morrell's U. S. Patent No. 2,169,809."

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry — Edited by Dr. O. W. Willcox.

REFINING

Finishing Wax Without Using Sweet Pans—D. A. Young in OIL & GAS JOURNAL, Vol. 40 (1941), No. 11, pp. 34-37.

The new dewaxing plant of the Sinclair Refining Co's. Houston refinery is unique in that use is made of multiple solvent dilution with dewaxed-oil recirculation in order more completely to remove the wax or oil. No sweating occurs in the preparation of any one of a complete range of commercial melting point waxes. The solvent used is composed of methyl ethyl ketone 45, toluene 15, and benzene 40 percent. Various stocks may be treated in various ways; operations on a typical waxy-oil neutral distillate are about as follows:

The oil is usually initially mixed with an equal portion of solvent and heated to approximately 140° F., though heavy distillates or a long residuum may be heated to 160° F.; the heated mixture is then counter-currently cooled and finally chilled to about 15° F.; here supplemental quantities of solvent may be added according to tests that show what amounts are necessary to obtain the highest yield of wax. Recirculation of a portion of the dewaxed oil is found to be advisable as it seems to promote the formation of wax crystals and improves their filtration, which is done on rotary vacuum filters. The wax cake on the filter drum is sprayed with cold solvent to wash it free from most of the oil. As the solvent forms an explosive mixture with air, operations are conducted in atmosphere of inert gas (CO_2). The dewaxed oil is heated and sent through a flash tower to recover the solvent.

The crude wax from the rotary filters is still somewhat contaminated with solvent and a trace of oil. This crude product is freed from volatile materials by passing it through a two-stage distillation unit. The slack wax from this stripping operation is then processed through a rotary vacuum filter for the second deoiling operation, which is done in lieu of the conventional sweating operation. This second deoiling is simply a repetition of the previous process

G. A. WELDING *Shop Notes*

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of adding solvent, chilling, filtering and collecting the deoiled cake, although a much larger volume of solvent is used; this solvent is of course recovered as previously described. The resulting wax is classified as crude scale, or semi-refined. If it is to be offered as a "finished semi-refined" wax it is given a sulphuric acid and an alkali wash, after which it is deodorized and filtered through fuller's earth.

The deodorizer is unique in the oil industry, but it is necessary for the manufacture of odor-free wax. It consists essentially of a small bubble tower for contacting the wax with superheated steam at 350° F. To make fully refined wax the untreated semi-refined product is sent back to the extraction plant for a third solvent processing. After passing through the regular procedure of acid and alkali washing, deodorization, and percolation-filtration it comes out as fully refined wax.

The plant was designed to turn out 20 tons of refined wax per day from 3,000 bbl. of neutral distillate or 2,500 bbl. of heavy lube stock. It has operated so successfully that its capacity is to be increased.

Microbiological Deposits in Water Circuits—D. R. Johnson and C. N. Rhoades, before DIVISION OF REFINING, AMERICAN PETROLEUM INSTITUTE, Tulsa meeting, May, 1941.

An Oklahoman refinery located on the banks of the Arkansas river found that its condensing and cooling surfaces were becoming fouled to such an extent that declining efficiency made cleaning every two months imperative. An examination of the fouling material showed the presence of abundant blue-grey fungi, bacilli and other microorganisms. A chlorinator was installed to treat 500 g.p.m. of water with 43 lbs. of chlorine in 24 hours. The result has been, first, that condensers have not required cleaning after two years, although they have been taken down for annual inspection, and secondly there was better cooling effect and greater ease in maintaining vacuum. Discontinuance of the chlorine treatment was usually followed by reduction of vacuum as much as 1.2 inches below normal.

It is brought out that "bio-fouling is a factor in corrosion of structural materials, and sometimes leads to accumulation of silica in boilers. Zeolite water softeners have their efficiency reduced by deposition of a slimy growth, which may be prevented by a previous chlorination of the water.

Caustic-Methanol Mercaptan Extraction Process—H. W. Field, in OIL & GAS JOURNAL, Vol. 40 (1941), No. 2, pp. 40-41.

A process which the author hails as a radically new refining process has been developed by Atlantic Refining Company. It is a method for removing mercaptans from gasoline by extraction with a mixture of caustic soda and methanol. In the process the caustic is continually regenerated and the methanol almost entirely recovered. The process is shown to make noteworthy savings in tetraethyl lead and to permit the use of a larger proportion of sour crudes. It is pointed out that the process opens new margins to a considerable number of refiners who have reached the practicable limit of octane rating obtainable by leading, and are faced by the necessity of installing new refining processes that give high-blending-value products, and which may involve costly installations in order to meet mounting octane requirements.

The system is fairly simple and the flow diagram is outlined as follows: A hydrogen sulfide free gasoline is charged to the base of a tall counter-current extraction column, packed with Raschig rings. Methanol is introduced in the middle of the column and a concentrated aqueous solution of caustic soda is fed in near the top. The column is operated in the conventional manner, the gasoline passing upward and disengaging cleanly at the top. The caustic-methanol solution is drawn from the base of the extraction column and passed to a stripping column. From the stripper, which is fitted with an internal reboiler, methanol and water pass overhead to collect in a separator in two layers, the upper one mercaptan and the lower water-alcohol, the ratio of water to alcohol being regulated to keep it at the point of minimum solubility of mercaptan. In the stripping column, the caustic is regenerated and thence returned to the extraction column. The methanol-water passes from the separator to a small fractionating column, where the alcohol is taken off overhead and is returned to the extraction column, while the water from the base of the fractionating column returns to the stripping column.

The caustic-methanol solution is not more than 3 percent of the volume of the gasoline, which makes it possible to regenerate the caustic in a small apparatus. Alcohol losses are 0.004 percent or less, figured on volume of gasoline. An outstanding feature is that the process can easily handle gasolines of high phenol (tar acid) content.

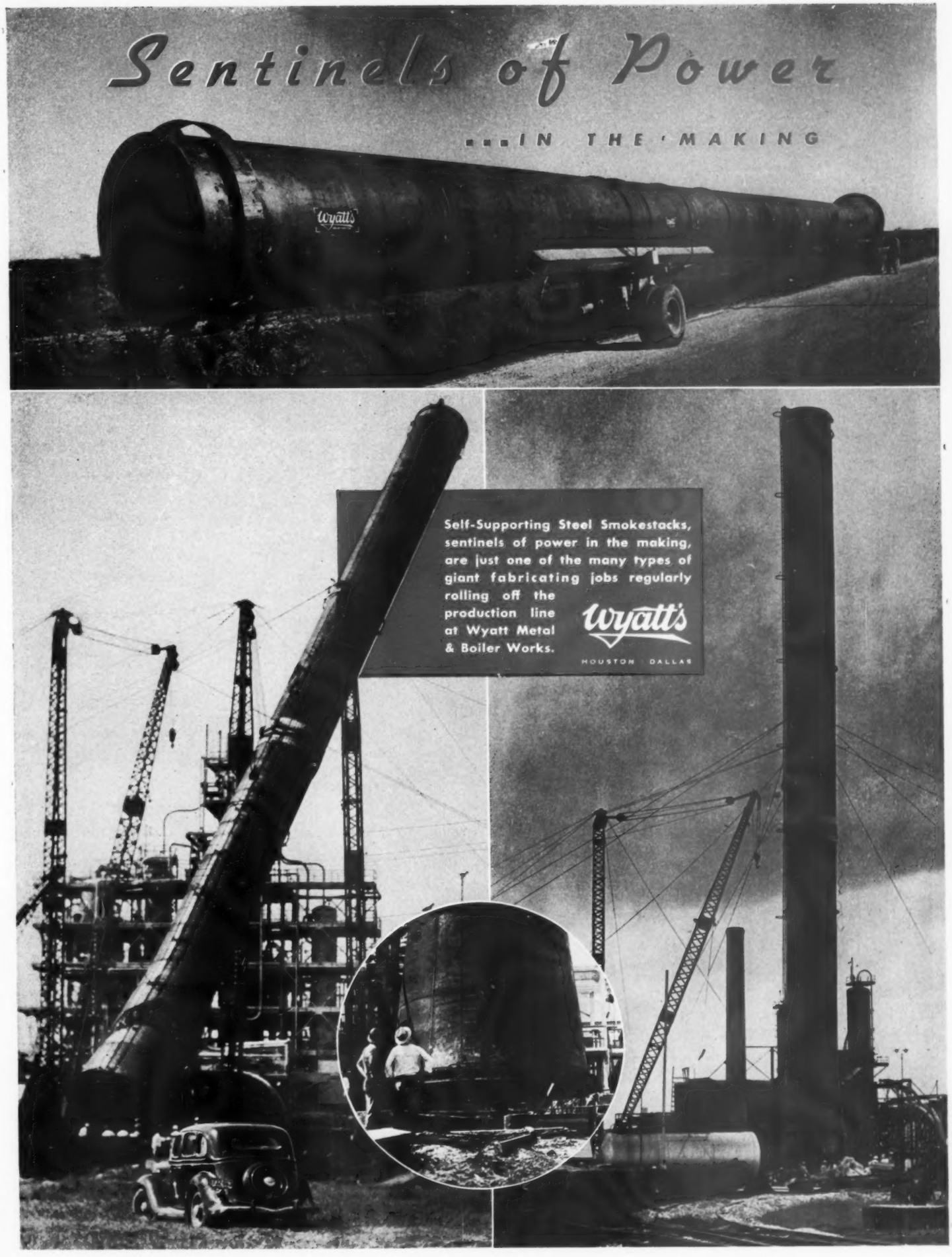
Sulphuric Acid Treatment of Bicarbonate Water to Prevent Scaling—N. Newton, before DIVISION OF REFINING, AMERICAN PETROLEUM INSTITUTE, Tulsa meeting, May, 1941.

At the Continental Oil Co's. refinery at Wichita Falls, Texas, the water for cooling had a temporary hardness of 514 p.p.m. and a permanent hardness of 56 p.p.m. The decomposition of lime bicarbonate on contact with hot surfaces necessitated de-scaling operations every 20 or 40 days, depending on the state of the weather. Much of the cooling equipment was difficult to get at, so that perhaps actually clean surfaces did not exceed 75 percent of the total surface. Exchanger tubes could usually be reamed out. Tar boxes would fill up with scale in 6 months, cooling coils had to be removed section by section and scale shoveled out of the box to reach the next lowest section. After a long run, barometer condensers of Corliss engines would be almost completely plugged. The difficulty might have been avoided by installing a zeolite water softener or a lime-soda water treating plant, but there was the question of investment, which would be large. At length it was concluded that since the lime bicarbonate was the chief offender it could be rendered harmless by a simple treatment with acid, which proved to be the case. A small proportioner was rigged up to supply 66 Beaume sulphuric acid at the rate of 4 lbs. per 1000 gallons of water. After that, no new scale was formed and the old scale began gradually to disappear. The amount of acid was adjusted so as to leave the circulating water slightly alkaline (pH 7.4.), thus avoiding acid corrosion. The action of the acid was to change the lime bicarbonate to lime sulphate, which remains in solution and does not deposit. An annual cleaning cost of $4700 was eliminated at a charge of $2500, but the main profit was in the better cooling of gasoline streams, decreased load on the gas compressor and avoidance of shut-downs.

Petroleum Refineries in the United States—G. R. Hopkins and E. W. Cochrane, in BUREAU OF MINES INFORMATION CIRCULAR NO. 716 (1941).

According to the annual refinery-capacity survey of the Bureau of Mines, the number of refineries in the United States showed little change in 1940, increasing from 557 the first of the year to 562 at the close. Although a number of plants were dismantled in Texas and other States, more than compensating gains were made in California, Illinois, and other States.

Low gasoline prices, competition for crude-oil supplies, and the termination of a favorable distributing arrangement for independent plants in the Los An-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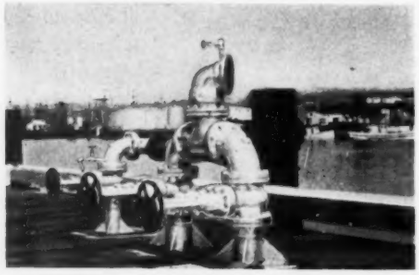

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geles area, forced about 50 refineries to close down in 1940. The number of operating plants accordingly declined from 461 on January 1, 1940 to 420 on January 1, 1941, and the number of idle plants increased from 86 to 136 in the same period; the operating capacity declining from 4,196,694 barrels daily on January 1, 1940 to 4,180,588 daily on January 1, 1941 and the idle capacity rising from 431,952 barrels to 538,381 barrels in the same period. However, the completed capacity on January 1, 1941 was 2 percent above the previous year.

Current crude runs to stills are about 3,600,000 barrels daily, indicating an effective utilization of 85 percent of the capacity in operation. The remaining 15 percent (nearly 600,000 barrels) appears ample to take care of any expected increase in demand during 1941. In addition there are about 500,000 barrels daily of idle capacity, 80 percent of which was reported in "good shape," the first of this year. As further insurance against a shortage of refined products there were 141,225 barrels of crude-oil capacity under construction.

Completed cracking capacity, which, except for 1932, increased every year since 1925, was 5 percent higher on January 1, 1941 than on January 1, 1940. There was only 82,042 barrels of idle cracking capacity on January 1, 1941, representing a somewhat lower proportion than with crude-oil capacity. Of this idle capacity, 69,772 barrels or 85 percent, was reported in "good shape." There was 94,685 barrels of cracking capacity added in 1940 compared with only 37,501 barrels dismantled or otherwise retired. The new capacity under construction on January 1, 1941 totaled 48,145 barrels, only 7,800 barrels of which was for replacement.

As the present output of cracked gasoline is about 850,000 barrels daily.

Oxidation Characteristics of Pure Hydrocarbons—R. E. Thorpe and F. A. Armfield, before DIVISION OF PETROLEUM CHEMISTRY, AMERICAN CHEMICAL SOCIETY, Atlantic City, September, 1941.

Lubricating oil in modern automobile, tractor, and airplane engines is subjected to extreme heat in the presence of air, which tends to cause its breakdown to oxidation products. Some of these are insoluble in the oil and coat the working parts of the engine, interfering with lubrication and causing oil lines to clog and valves and piston rings to stick.

Other oxidation products are corrosive to engine bearings, especially those commonly used in high output engines. For guidance in the development of improved oils to resist such breakdown, the authors have made a fundamental study of the behavior of a large number of hydrocarbons of various types similar to the hydrocarbons that make up lubricating oils.

Contrary to generally accepted views that the paraffins and cycloparaffins are exceptionally resistant to oxidation, the authors have found them more easily attacked than are certain types of compounds containing fewer than the maximum number of hydrogen atoms; of these, compounds of fish-net structure, called polynuclear aromatics, proved exceptionally stable. On the other hand, if such compounds contained only a single ring, or still worse, no ring, they were quite unstable.

It is remarkable that the instability of saturated hydrocarbons does not lead to instability of well-refined oils of which they are prominent constituents. The authors have concluded that substances are naturally present in such oils which tend to protect them. These protective substances are, however, removed by the drastic refining sometimes required to

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eliminate undesirable constituents, and in such case it is necessary to add protective compounds, natural or synthetic, to the refined oil.

While this fundamental study of hydrocarbon oxidation does not provide a ready recipe for producing superior lubricants, it contributes to the basic understanding which must underlie such developments.

DRILLING

Tapered Wire Lines—R. B. Anderson, before A. P. I., DIVISION OF PRODUCTION, Spring meeting, Pittsburgh, April, 1941.

In the course of a paper entitled "Problems involved in deepening wells from the Oriskany to the Clinton sand in West Virginia" reference is made to a type of wire line for cable tools which is being put on the market by at least one manufacturer. The idea is that when a relatively deep well is being drilled with cable tools, the cable at the surface has to support not only the tools but a mile or so of line in the well; the top section should therefore have a greater breaking strength than the bottom section. For a well that is to be drilled to 6500 feet, with eight-inch tools to 5000 feet, and six-inch tools to 6500 feet, the first section should be 3750 ft. of 7/8" line, the next 1750 feet tapered over its length to 1", which is held through the remaining 1500 feet. The taper is made by gradually increasing the diameter of the wire and is not a splice. This gives a safety factor of 7 throughout the length of the line.

There is an important difference in the cost; 7,000 feet of tapered line costs $1708, whereas the same footage of 1" line costs $2415.

PHYSICS

Calculation of Front End Volatility of Gasoline Blends—N. B. Haskell and D. K. Beavon, before PETROLEUM DIVISION, AMERICAN CHEMICAL SOCIETY, Atlantic City, September, 1941.

The increasing complexity of light hydrocarbon processing in a modern oil refinery requires adequate methods for calculating the front end volatility of various types of gasoline blends. The Reid vapor pressure and the ASTM 10 percent point are in general use as measures of this volatility. Methods are presented for the calculation of these tests on blends of refinery gasolines with natural gasolines, butane fractions, and pentane fractions. A general relationship between the RVP and the 10 percent evaporated point is an essential part of this method, as is a correlation for the prediction of the ASTM distillation loss from the C_4 and C_5 content of the stock. Accuracy of the method is good, being on the order of ± 0.2 lb. per sq. inch RVP and $\pm 2°$ F. 10 percent point.

Simple Methods for Calculation of Theoretical Plates Required for Separation of Two Normal Liquids by Batch Fractionation.—Arthur Rose, before DIVISION OF PETROLEUM CHEMISTRY, AMERICAN CHEMICAL SOCIETY, St. Louis meeting, April, 1941.

For mixtures of similar normal liquids with normal vapor liquid equilibrium relations, and in cases where the usual simplifying assumptions of distillation and negligible holdup are justified, the equations

$$n = \frac{2.85}{\log 10\alpha} = R \text{ and } n = \frac{T_B + T_A}{3(T_B - T_A)} = R$$

are suggested for estimating approximately the equivalent number of theoretical plates (n) and the reflux ratio (R) suitable for a standard separation in which the first 40% distilled has an average purity of 95 mole %. The derivation of the equations is described, the limitations of such approximation formulas are emephasized, and they are compared with a correlation of more accurate Rayleigh type calculations which show that the number of plates required may be chosen from any value within a limited range, provided the accompanying reflux is properly fixed. The limits of the range of plates required and the methods of choosing the proper reflux are indicated. The temperatures in the above equations are °K and T_B is the higher temperature.

NATURAL GAS

Natural Gas Dehydration Units for Individual Wells—R. B. Anderson before A. P. I., DIVISION OF PRODUCTION, Spring meeting, Pittsburgh, April, 1941.

Rock pressures in excess of 1000 lbs. in West Virginia have permitted the operation of field lines at pressures of 300 to 600 lbs. These pressures have introduced the problem of hydrate formation at temperatures as high as 55° F. This paper describes

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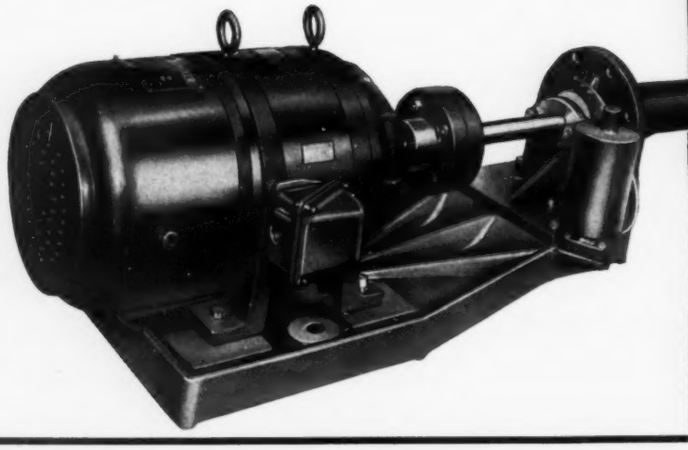

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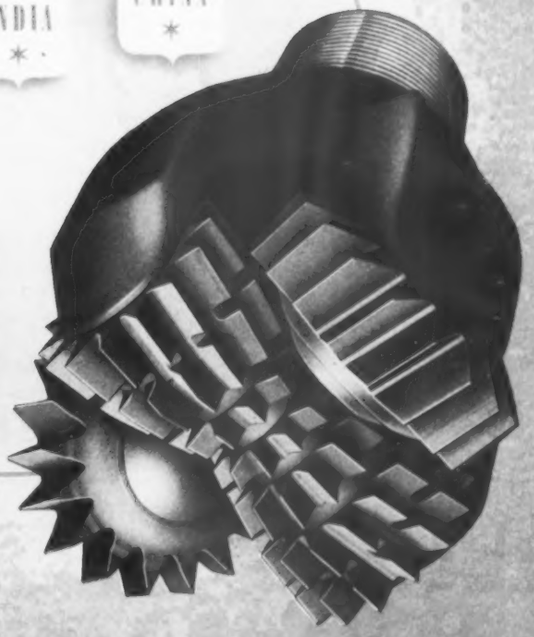

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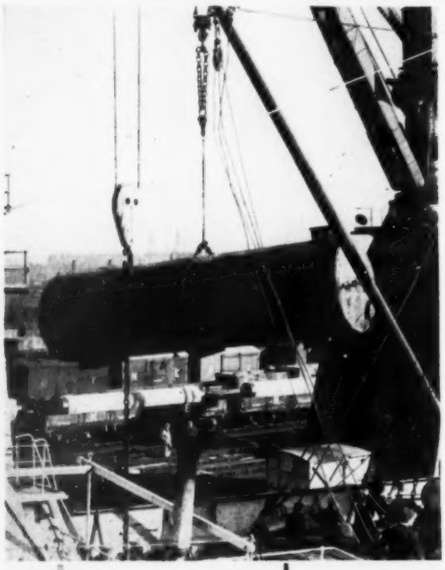

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small volume, automatic natural gas dehydration units designed for treating natural gas at individual wells to solve this problem. The paper gives an extensive description of the method employed, detail drawings showing the design of the equipment, charts and curves illustrating results that can be obtained with the use of diethylene glycol for dehydrating natural gas, and charts of the physical properties of diethylene glycol.

It is acknowledged that nothing new in principle is offered. The distinctive feature lies in the design that adapts the methods to the limiting factors of a well-head dehydration unit.

ASPHALT & TAR

Bituminous Coatings—A. O. Beckman and Others, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 33 (1941), No. 8, pp. 984-990.

It not infrequently happens that some time after a clean metal surface has been coated with a bituminous preparation a certain amount of rust is found beneath the coating. How could that happen? Up to the present the literature has contained no explanation, hence the research recorded in this paper.

It was presumed that three circumstances might be responsible: Water may penetrate through the layer of bitumen by the process of electroosmosis, by diffusion of electrolytes, or through small holes or fissures in the membrane. All three were studied experimentally.

It was found that electroosmosis and ionic diffusion of water is not sufficiently large to account for the amount of rusting frequently encountered in commercial experience. From surface tension and wetting angle measuremets of the bituminous membrane-aqueous solution interface, it is shown that a pinhole imperfection of 0.1-mm. radius will permit penetration of water to a depth of several centimeters in some bituminous membranes.

In the same number of the same Journal, p. 991, is a paper on the same general subject by A. P. Anderson and K. A. Wright of the Shell Development Co. They reached the same conclusion, namely, that penetration of bituminous coatings by diffusion is so slight as to give rise to only a negligible corrosion, and that bituminous coatings (asphalt) will protect metal pipes as long as the asphalt coating remains microscopically intact.

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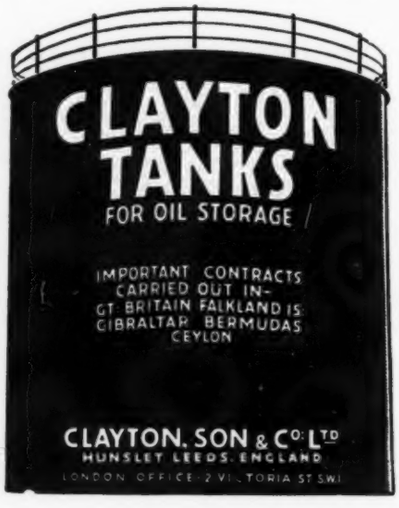

BOOKS

Petroleum and Natural-Gas Fields in Wyoming By Ralph H. Espack and H. Dale Nichols. Published 1941 by U. S. Bureau of Mines, Washington; $25 (with maps).

This work describes the development of Wyoming as a petroleum and natural gas producing state from early pioneering days through the peak year of 1923, when it was the fourth largest producer, down to recent years when it ranked eighth among the oil yielding States of the Union.

The authors start off with a historical resume beginning with 1833 when Indian guides called the attention of Captain Benjamin Bonneville to an oil seep

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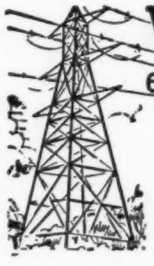
in what is now the Dallas Dome Oil field in Fremont County. Already in the 1850's there was a Wyoming oil industry capable of supplying petroleum as a base for axle grease for the wagons of emigrants and freighters using the California trail. The first drilled hole was put down in 1884 to a depth of 300 feet; it tapped oil and gas that flowed spasmodically, and some of the products were horse-hauled 150 miles and marketed at stations along the Union Pacific railroad. In the 1890's there was a pool which produced oil on a scale that required 12- and 16-horse teams to haul it 45 miles to the nearest shipping point.

However, the historical part of it is brief. The business at hand is to describe the approximately 85 geological structures in Wyoming which have been found to contain petroleum, natural gas, or both, and the 75 oil or gas fields on these structures that are producing or have produced some oil or gas of commercial value. Each of these 75 fields is discussed with the view of furnishing such pertinent information and data as are available; minor details are necessarily omitted. The descriptions of the fields are supplemented by 72 illustrations, mostly maps and sections, some of which are large and detailed. There is an extensive bibliography classified by fields. An appendix contains numerous analyses of oils, gases and waters, together with tables showing oil and gas production of the individual fields by years.

The Cracking Art in 1939; edited by Gustav Egloff. Published 1941 by Universal Oil Products Co., Chicago, paper, 617 pages.

Developments in cracking are grouped under six heads: Cracking research (pyrolytic, catalytic, electrical, photochemical and radiochemical), com-



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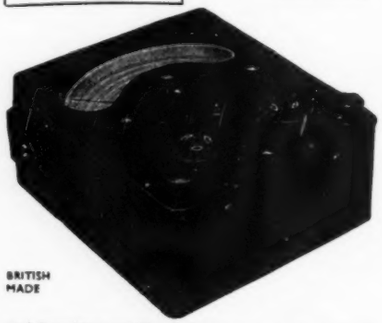

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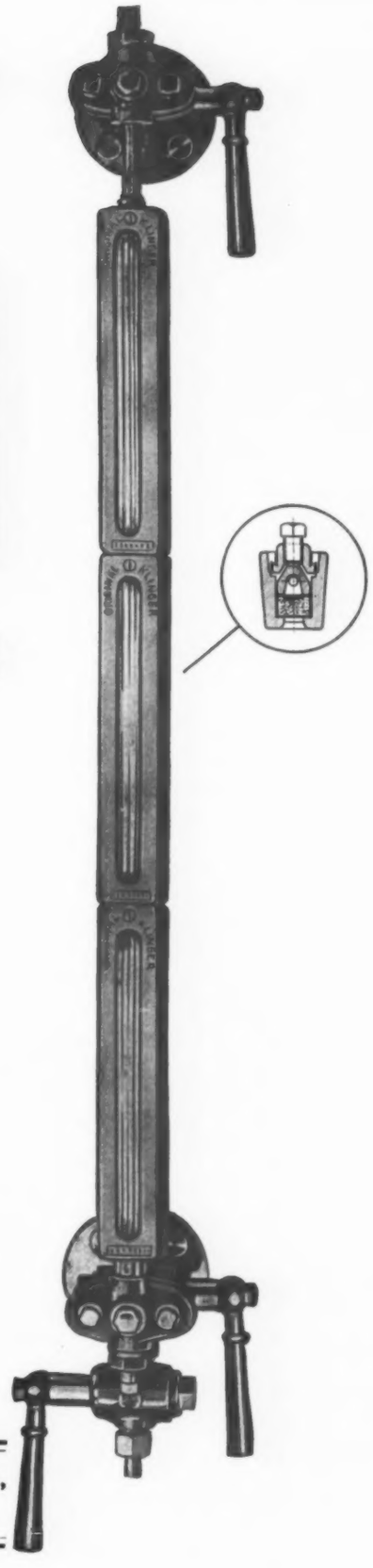

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The year 1939 was marked by a number of impressive developments. The war occasioned a large demand for high octane fuel and quickened the development of processes for producing this commodity. It is probable that this will have a lasting effect on the refining industry, as a part at least of this production will be used to improve the quality of gasoline for automotive use. The year also witnessed a strong development of catalytic cracking processes; catalytic reforming of gasolines came into prominence, thermal alkylation for production of neohexane from isobutane and ethene became successful, and small catalytic polymerization units were put within reach of the small refiners. The development of polymerization and alkylation processes brought an increase in the utilization of refinery and natural gases as raw materials. Butanes were successfully converted into butenes and these into isooctanes. Butadiene from petroleum became a practicable source of material for synthetic rubber. Along with these developments there was much development of new refinery equipment, particularly in vessels subject to high pressure, high temperature and corrosion. Valuable new alloys were introduced, more elaborate instrumentation was developed for automatic operations, and there was a movement toward closer integration of topping, cracking and refining units. All these and many more can be studied by the reader who consults this review.

USES

The Evaluation and Performance of Turbine Oils—G. H. von Fuchs, N. B. Wilson, and K. R. Edlund before Division of Petroleum Chemistry, AMERICAN CHEMICAL SOCIETY, St. Louis meeting, April, 1941.

Progress in the design and construction of steam turbines has introduced new problems in lubrication and aggravated old ones. The importance of predicting the behavior in service of turbine oils has led to the development of suitable accelerated laboratory tests. Two essential requisites of a good turbine lubricant are the ability to protect steel surfaces against rusting and high stability toward oxidation. Application of these tests has revealed striking differences among the leading turbine oils. A discussion is presented of the chemical factors which influence the performance of oils in relation to the various methods employed by turbine operators to maintain an oil in serviceable condition.

Consistency Test for Lubricating Greases. Counter-Balance Modification for Soft or Liquid Greases—Harry Levin and Charles J. Schlagel before Division of Pettroleum Chemistry, AMERICAN CHEMICAL SOCIETY, St. Louis meeting, April, 1941.

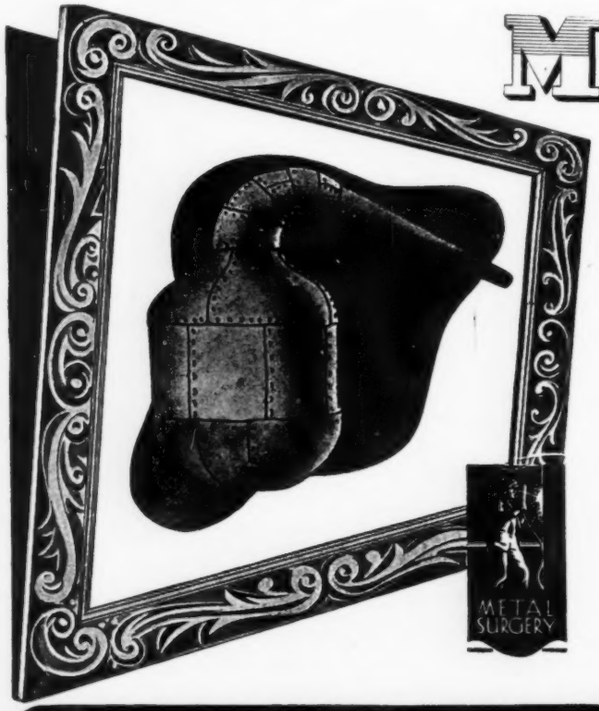
A simple modification of the ASTM method for determining consistency of lubricating greases is described which extends the utility of the ASTM apparatus and method to very soft and liquid greases. Although it does not interfere with regular ASTM penetrations the apparatus modification is one that can be installed or removed in a few minutes by simply disconnecting a thread. In essence, the modification consists in counterbalancing the moving weights of the ASTM apparatus (150 grams) to any desired lesser weight. The use of such lesser weights brings the penetration of very soft greases within the scale of the standard apparatus.

Laboratory Evaluation of Some Factors Causing Lubricating Oil Deterioration in Engines—R. E. Burk, E. C. Hughes, W. E. Scovill, and J. D. Bartleson, before DIVISION OF PETROLEUM CHEMISTRY, AMERICAN CHEMICAL SOCIETY, Atlantic City, September 11, 1941.

While various laboratory tests for evaluating the quality and particularly the stability of lubricating oil have declined, the need for such a test is still very great. Engine testing is so expensive and requires so much equipment and time that it is scarcely a practical routine procedure for each car of oil. Moreover the information which engine tests yields is limited.

The authors have devised a laboratory test which, like certain other tests, subjects the oil to elevated temperature, air and metals. Temperature and metal catalysis are found to be the dominant variables. In this test the ratio of metal area to oil volume is adjusted to the value which exists in a particular engine in which the performance of the oil is to be evaluated. Oil is circulated over the metal catalysts by means of jet propulsion by an air stream.

The mechanical arrangement is such that all metal surfaces are parallel to the axis of flow of oil and air, and are readily cleaned by solvent action and burnish-



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ing. The volume of air used per unit volume of oil is adjusted to that value which passes through the crank case of the chosen engine at a particular speed at which it is desired to estimate the stability of the oil. This gives comparable retention of light acids.

GENERAL

Petroleum Engineering Study of the Anahuac Field—Charles E. Carpenter and H. J. Schroeder in BUREAU OF MINES REPORTS OF INVESTIGATIONS No. 3579, 1941; 37 pp. with maps and illustrations.

The Bureau of Mines selected the Anahuac field in Chambers County, Texas, for a study designed to point out means of improving existing methods of estimating reserves in petroleum reservoirs by applying all the data that are collected during the development of an oil field by means of coring, electric logging, micropaleontology, determinations of porosity, permeability of oil-bearing sands and their connate water content, subsurface sampling of the reservoir oil, and depth-pressure measurements. These lead to conclusion regarding the oil content in a unit space of the reservoir. The cubic volume of the reservoir is computed from average end areas plotted on cross sections and from data shown on an isopachous map; the results obtained by the two methods differed by only 1.39 percent.

The methods and formulas used to calculate the ultimate oil and gas recovery have been described in detail in the body of the report. As a result of the refinement in estimates of reserves made possible by modern engineering technique, the so-called porosity-saturation method is best for estimating the ultimate recovery of crude oil and natural gas from a reservoir of the Anahuac type. In this procedure the net volume of the producing sandstone in the reservoir is computed from subsurface records of the wells, and porosity, saturation, and shrinkage of the oil are determined by analysis or experiment. Recovery is the only factor that cannot be determined by analysis or experiment and should be based as nearly as possible upon the records of depleted or nearly depleted fields that have similar characteristics or upon theoretical considerations.

Hydrogenation and Liquefaction of Coal—H. H. Storch, L. L. Hirst, C. H. Fisher and G. V. Sprunk in BUREAU OF MINES TECHNICAL PAPER, No. 622 (1941); 110 pages; 20c.

The United States has large deposits of both coal and petroleum. Although experts are not wholly agreed concerning the extent of the oil reserves of this country, it is generally admitted that they are not large enough to last indefinitely at the present rate of consumption. On the other hand coal resources are immensely larger and will undoubtedly last for many centuries. It is well known that petroleum oils can be fabricated from coal, so that when the natural petroleum is gone, gasoline and other oil products can still be made available.

Although this change-over may be far off, it will be well to prepare for it. For this reason the Bureau of Mines several years ago established an experimental plant to study the matter and accumulate data and ideas for future use. The present report contains the first fruits of these investigations. The task of the investigators was to develop an apparatus for liquefying and hydrogenating coal. After that, naturally came a survey of American coals to ascertain their suitability for the purpose; this varies according to the "rank" of the coal, which is roughly inversely proportional to their carbon content. The yields of oil range from 64 to 31 tons per 100 tons of coal or 160 to 78 gallons of oil per ton of coal mined; 20 percent of the product is gasoline, 70 percent is oil of medium viscosity which might be treated so as to bring the ultimate gasoline yield to 85 percent of the synthetic products.

There is as yet no question of making synthetic petroleum in the United States, but circumstances have imposed it on certain European countries. When the time does come for us the transition will no doubt be made without a break.

Wildcat Drilling in 1940—Frederic H. Lahee, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 25 (1941), No. 6, pp. 997-1003.

In this sixth consecutive report on wildcat drilling it is recorded that a total of 3,038 wildcat wells were drilled in the United States during 1940; these wells had a total footage of 10,253,448 feet (1948 miles). Out of this number there were 366 producers totaling 1,411,530 feet and 2672 dry holes with 8,842,418 feet (1642 miles). This means that 12.05 per cent of the holes drilled and 13.77 per cent of the footage were successful. The average depth of hole was 3,375 feet.

In this connection a wildcat well is defined in general as one that is drilled 2 or 3 miles from known production, although this limit may be reduced to ¼ or ½ mile if the subsurface conditions are known to be subject to abrupt change. "Semi-wildcats," or wells that are deepened in search of possible but unknown new production are not considered as true wildcats.

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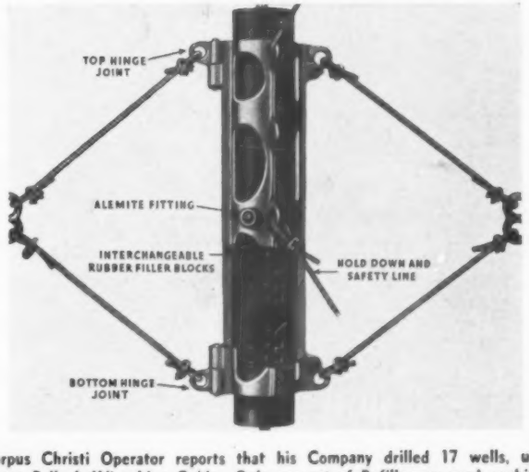

A Corpus Christi Operator reports that his Company drilled 17 wells, using a Patterson-Ballagh Wire Line Guide. Only one set of Refills was used, making the average cost only $2.00 per well for guide service.

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According to information obtained, 320 wildcats drilled on technical advice (geology and/or geophysics) were successful (oil or gas), and 1,731 were dry; 35 holes located for non-technical reasons were producers, and 797 were dry; 11 producers and 144 dry holes were located for reasons unknown. These figures show that 15.6 per cent of the holes drilled on technical advice were producers as contrasted with 4.2 per cent successful in the case of the holes located without technical advice. Therefore, in 1940 locations based on technical recommendations were 3.7 times as successful as those drilled without such advice. In the southern states 4.4 per cent of the wildcats, located without technical advice, were producers, whereas 15.0 per cent of the holes located on technical advice were producers. Whereas in 1937 there were 3 times as many discovery wildcats drilled on technical advice as there were drilled for non-technical reasons, in 1938 this factor had decreased to between 2.2 and 3.2, and in 1939 it had further decreased to between 1.5 and 2.2. This year, in 1940, this factor has jumped to 3.7. There has been a stronger tendency than hitherto to seek technical advice before selecting a wildcat location, and especially is this true where deep drilling is contemplated. On subsurface geology, 793 locations were made as compared with 155 made on surface geology. On seismographic work, mostly reflection shooting, 431 locations were made whereas the remaining 115 locations listed under geophysics were based on the other types of geophysical exploration. Subsurface geology is by far the most important guide for selection of wildcat locations.

CHEMISTRY

Analytical Determination of the Research Octane Number of Fischer-Tropsch Synthetic Gasoline—Th. Hammerich, in OEL UND KOHLE, Vol. 37 (1941), No. 9, pp. 148-155.

Up to the present time no reliable analytical method has been found for determining the anti-knock qualities of gasoline from natural petroleum, which is apt to be a complex mixture of normal and iso-paraffins, olefins, five and six ring napthenes, and aromatics, although when these various categories of hydrocarbons are taken separately there is a practically linear relation between boiling point and octane number. The matter is relatively much more simple in the case of Fischer-Tropsch synthetic gasolines that are free from aromatics and naphthenes and contain only straight-chain paraffin series and the alpha-olefin series, which, considered separately, show the linear relation between boiling point and CFR Research octane number. In mixtures of these series the octane number will more or less closely depend on the proportions of normal paraffins and olefins.

The analytical determination of the octane number of these synthetic gasolines therefore depends on finding a dependable method of determining the olefin content. The classic method of extraction with fuming sulphuric acid is not sufficiently accurate. The author gives preference to the Rosenmund and Kuhnhenn method .. *Nahr u. Genussm. 46*, 154 (1923); *Ber. 56 1262* (1923), which gives results hardly differing from theory. From this determination of the unsaturated components the author derives a basis for calculating the "Olefin Index" (O. I.) of gasolines which have been freed from C_3 and C_4 components

A New Graphical Method of Evaluating the Engler Distillation. F. W. Meiser, Oel und Kohle. Vol. 37 (1941), No. 17 pp. 297-300.

One of the most important properties for judging a mineral oil is its distillation character, which is determined (in Europe at least) by the Engler distillation method in which quantity of distillate is recorded as a function of temperature. When the operator distills a number of different oils he gets columns of figures which cannot be easily or quickly compared.

In an attempt to obtain easier comparisons, W. Ostwald introduced what is known as the "boiling index (Siedekennziffer)." In this method a "boiling curve" is plotted with volumes in percent against temperature; the "boiling index" is the integral, or area of the surface below the boiling curve. This integral is determined by adding up the percentage volumes (5, 15, 25 . . . 95 vol. %) and dividing the sum by 10. This method runs into the difficulty that oils of radically different compositions may give the same boiling index.

In the new method a diagram is constructed by plotting the temperatures on the Y-axis; on the X-axis the amounts (in %) of distillate passing over within each temperature interval of 10° C. are plotted on both sides of a line perpen-

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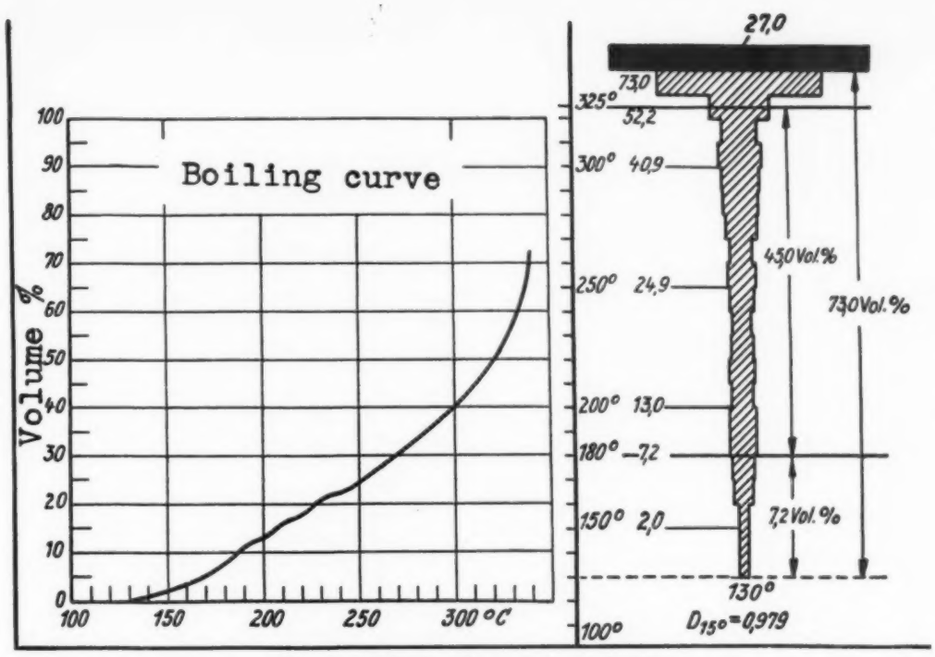


Fig. 1. Distillation diagram of a shale oil.

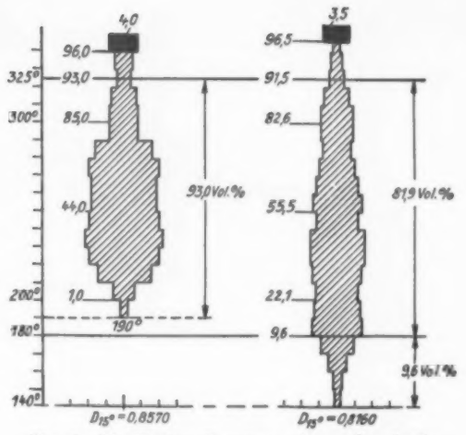


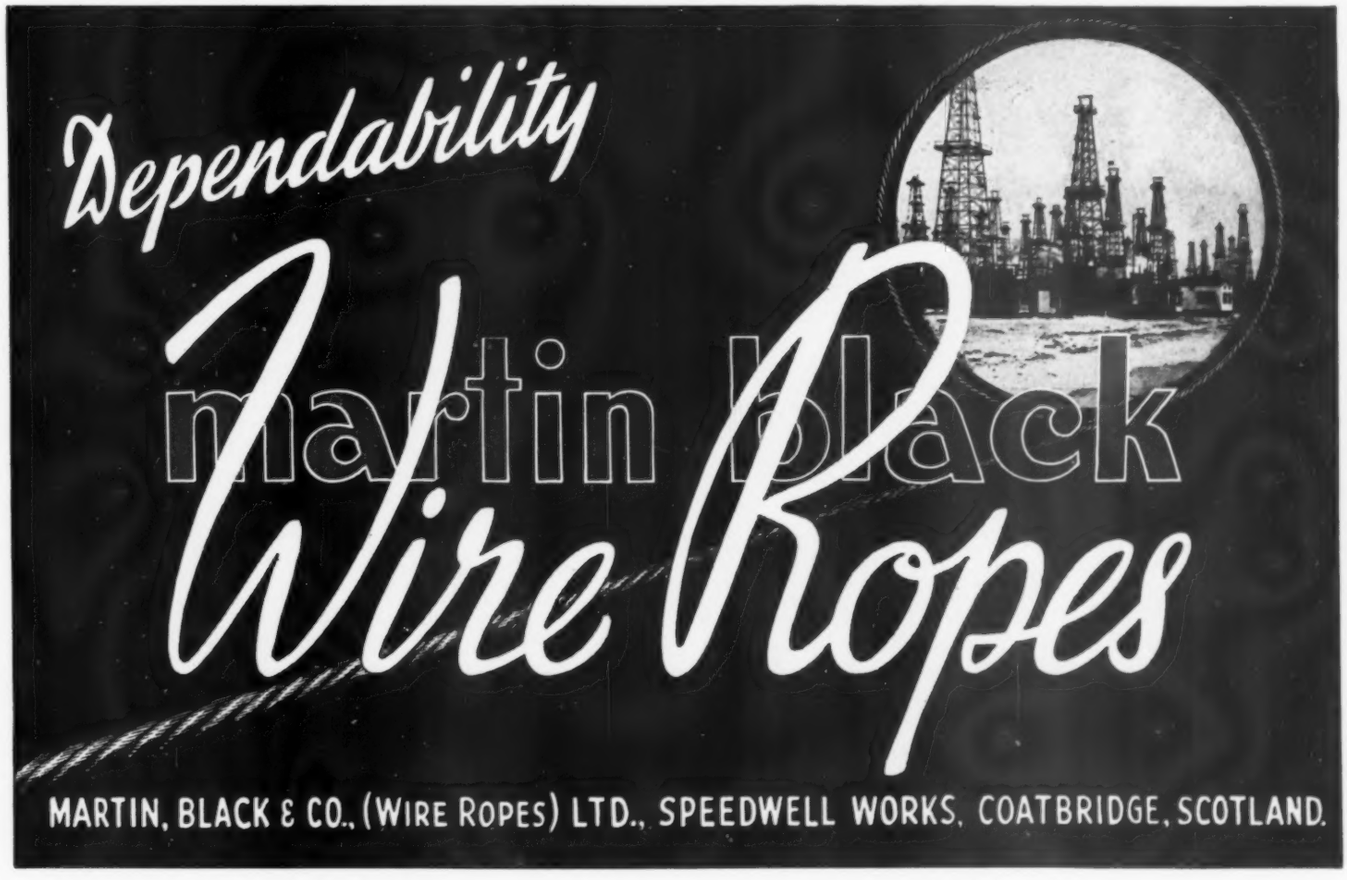
Fig. 2. Distillation diagrams of two diesel oils.

dicular to the Y-axis. In this way, one obtains diagrams that may have various striking shapes, such as a "turnip", an "onion" or a "hammer" (see illustrations). These diagrams express characters that are seized upon by the eye at the first glance; it is easy to tell whether or not a diesel oil contains a large proportion of oils in the gasoline range, etc.

In the new diagrams the distillation residue is clearly recognized at the head (solid black). The 180° C. line (gasoline limit) or the 325° C. line (naphtha limit) etc., may be emphasized by black lines. It is found advisable to enter the data on the diagram so as to have the quantity of distillate which distills at a given temperature on the left of the X-axis, and on the right the numerical order of amounts of distillate that come over between two chosen temperatures.

Figure 1 herewith shows the distillation data of a Jugoslav shale oil. At the left is the ordinary Engler distillation curve. At the right is the Meier-Wesolofsky distillation diagram which here has a pronounced "hammer" form that could hardly be inferred from the boiling curve.

Figure 2 shows the Meier-Wesolofsky diagrams of two diesel oils. The one on the right shows a considerable content of light fractions which give the "carrot" a longer tapering "root". The one on the left approximates the form of a "radish" with a short, stumpy root.



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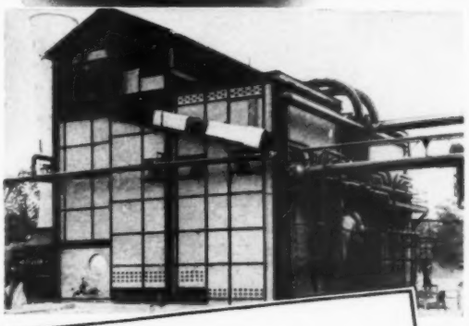

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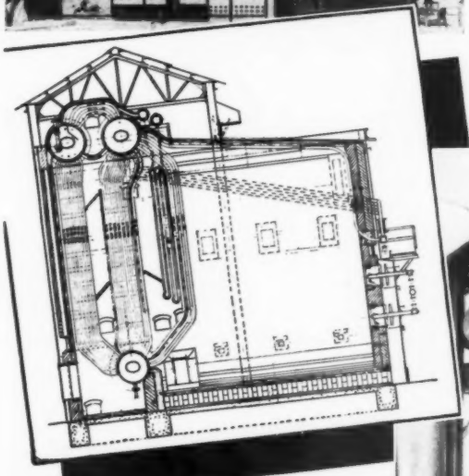

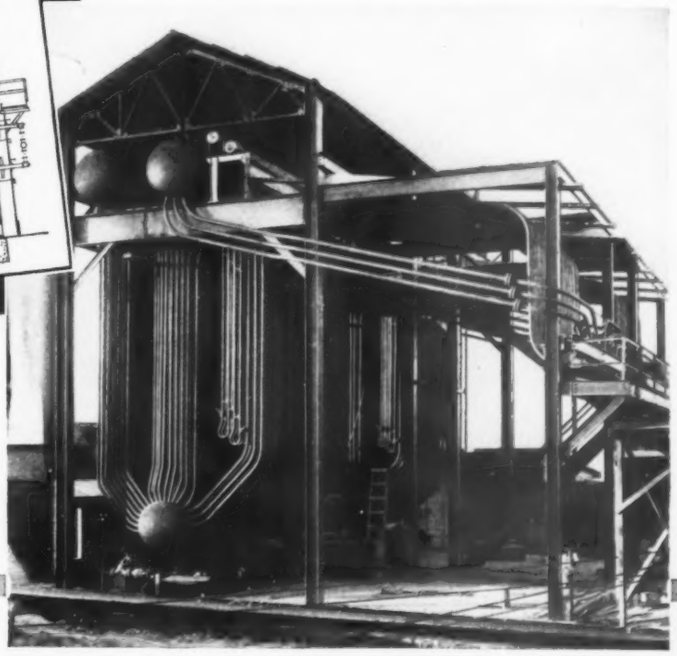

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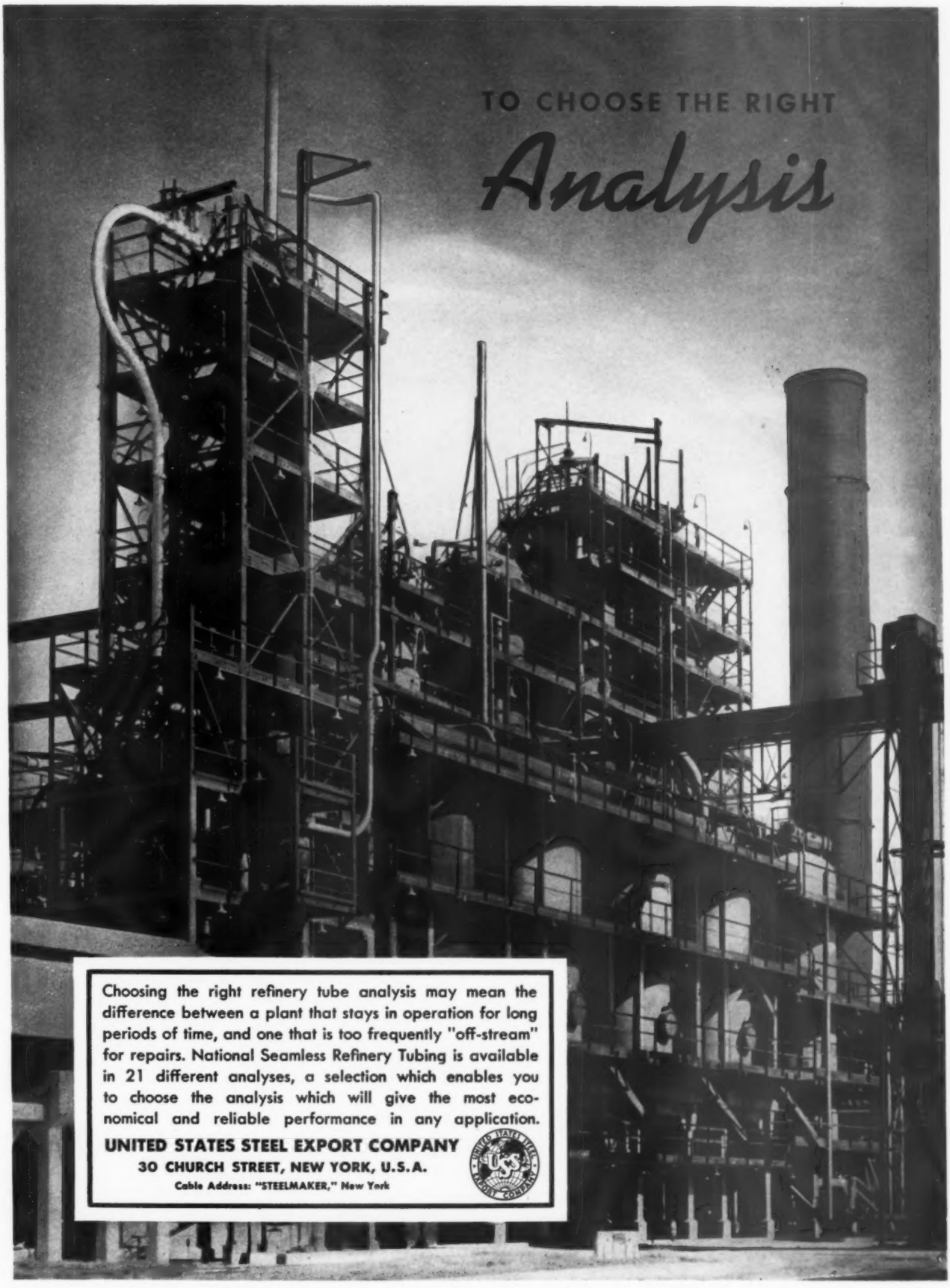
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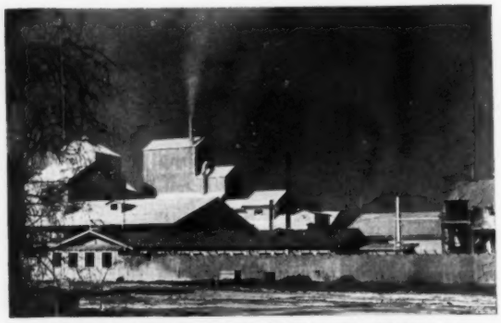

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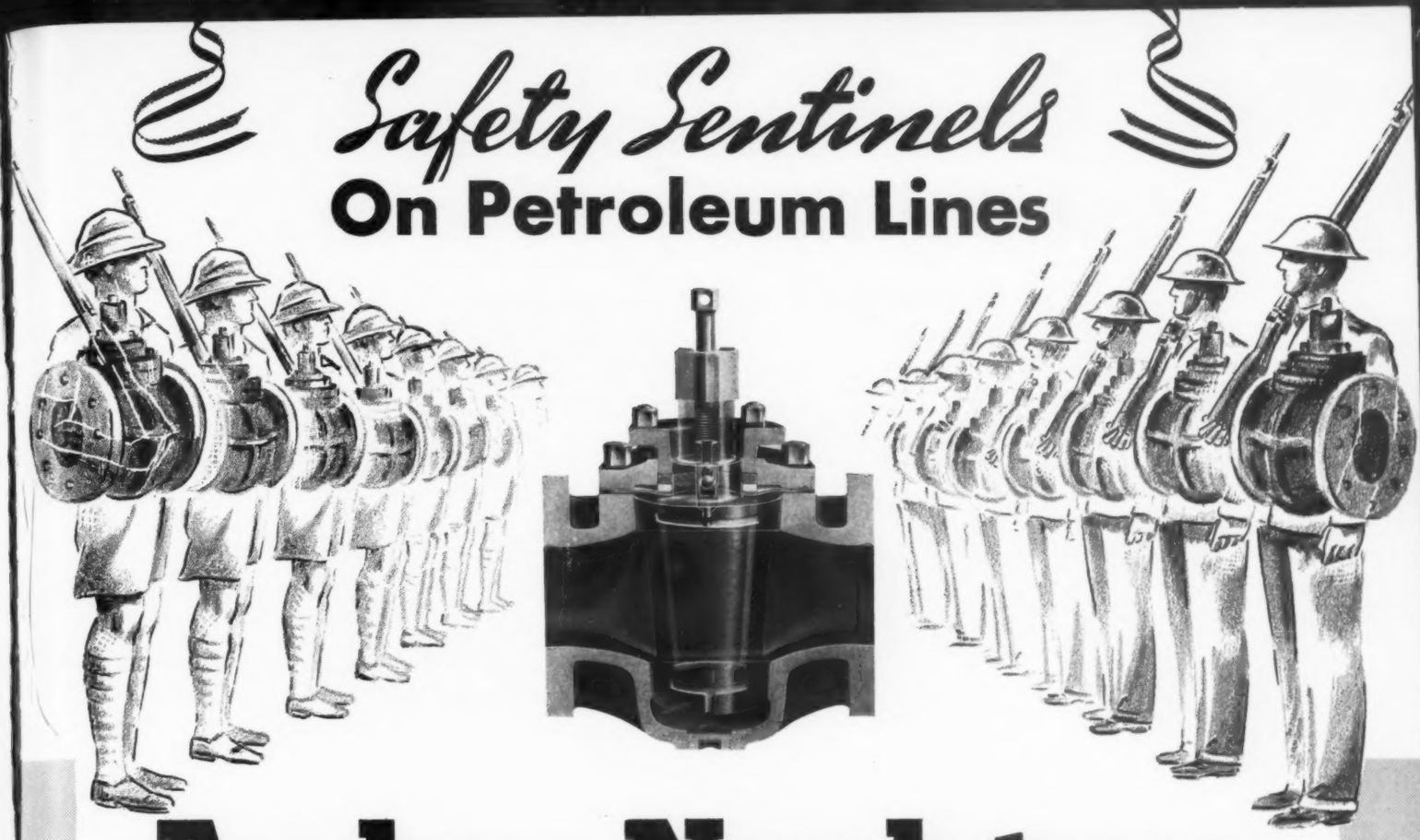

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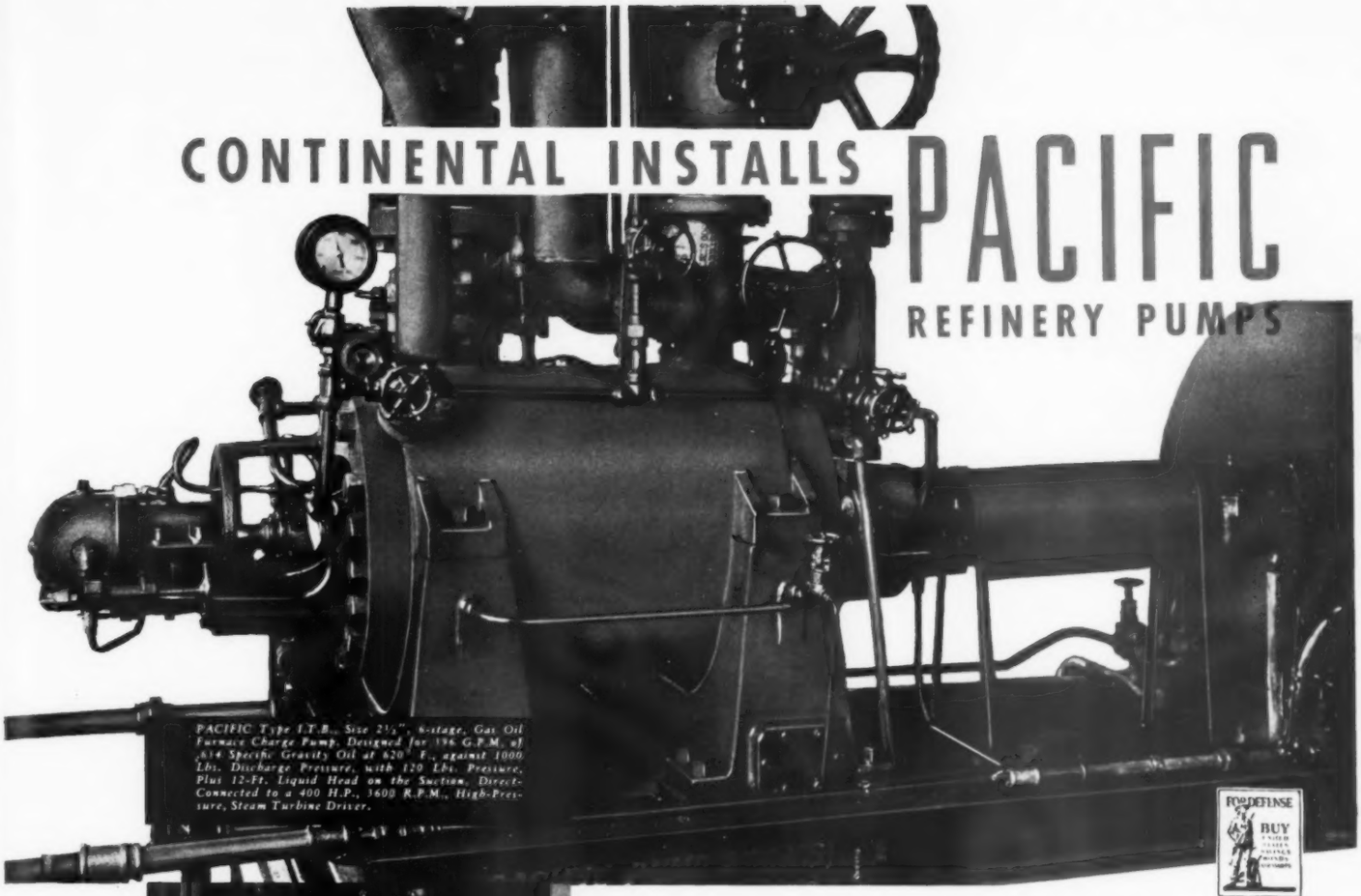
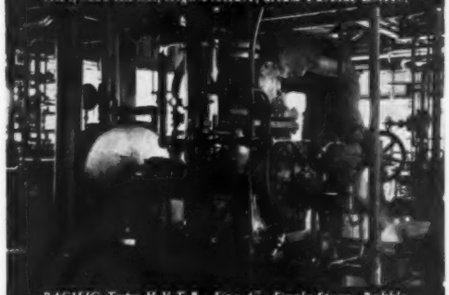


PACIFIC Type I.T.B., Size 2½", 6-stage, Gas Oil Furnace Charge Pump. Designed for 196 G.P.M. of .614 Specific Gravity Oil at 620° F., against 1000 Lbs. Discharge Pressure, with 120 Lbs. Pressure, Plus 12-Ft. Liquid Head on the Suction. Direct-Connected to a 400 H.P., 3600 R.P.M., High-Pressure, Steam Turbine Driver.

PACIFIC Type A.T.B., Size 2", 4-stage, Vis-Breaker Furnace Charge Pump. Designed for 170 G.P.M. of .666 Specific Gravity Oil at 710° F., against 650 Lbs. Discharge Pressure, with 115 Lbs. Pressure, Plus 12-Ft. Liquid Head on the Suction. Direct-Connected to a 150 H.P., 1600 R.P.M., High-Pressure, Steam Turbine Driver.



PACIFIC Type H.V.T.B., Size 4", Single-Stage, Bubble Tower Intermediate Reflux Pump. Designed for 751 G.P.M. of .611 Specific Gravity Oil at 620° F., against 300 Lbs. Discharge Pressure, with 111 Lbs. Pressure, Plus 10-Ft. Liquid Head on the Suction. Direct-Connected to a 150 H.P., 1600 R.P.M., Non-Condensing, Steam Turbine Driver.

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PACIFIC Hot Oil Pumps were specified for three vital services in the new Continental Oil Company Refinery at Westlake, Louisiana. These three PACIFIC Pumps are supplied with stainless steel internal parts to resist corrosion conditions of the high temperature oil being pumped. All pumps are centerline mounted on water-cooled bases. Stuffing boxes and bearings are water cooled. These pumps were shipped from the factory with water cooling and gland piping installed. This Continental installation is proof that refinery engineers recognize the superiority of PACIFIC Pump design and construction on essential pumping services.

Reasonable installation costs, low maintenance expense and long, trouble-free service records are reasons why PACIFIC Pumps are specified for the "tough" jobs.

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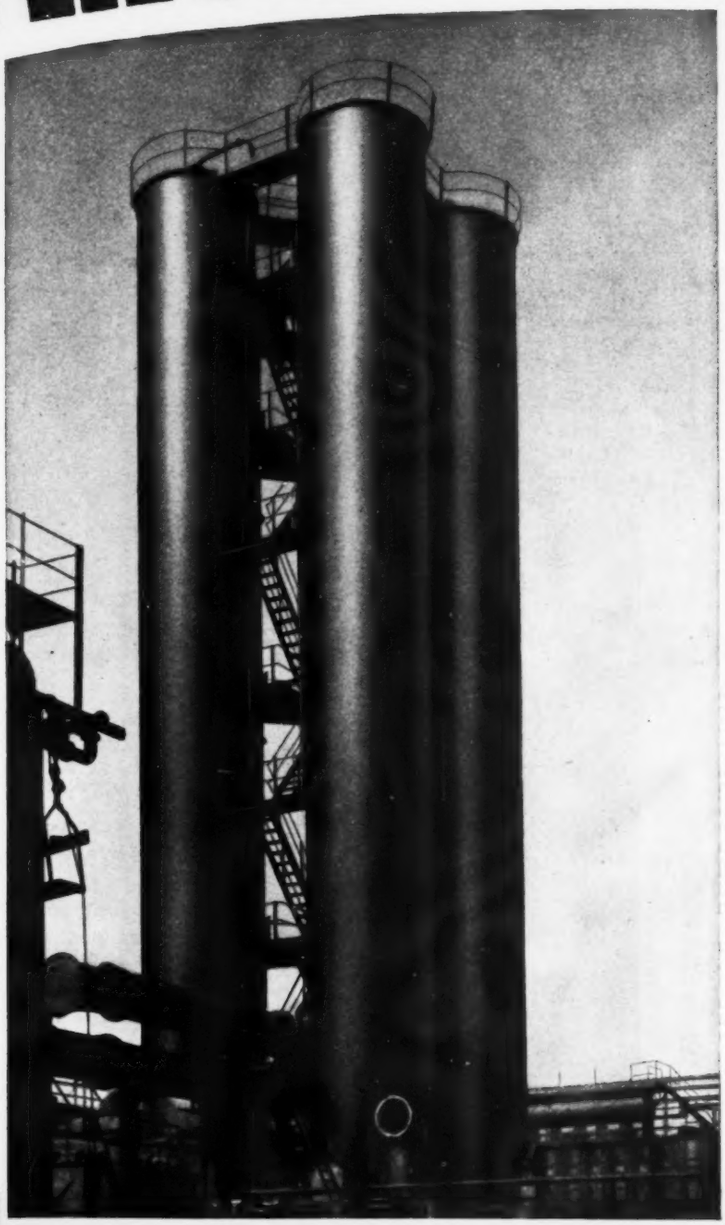

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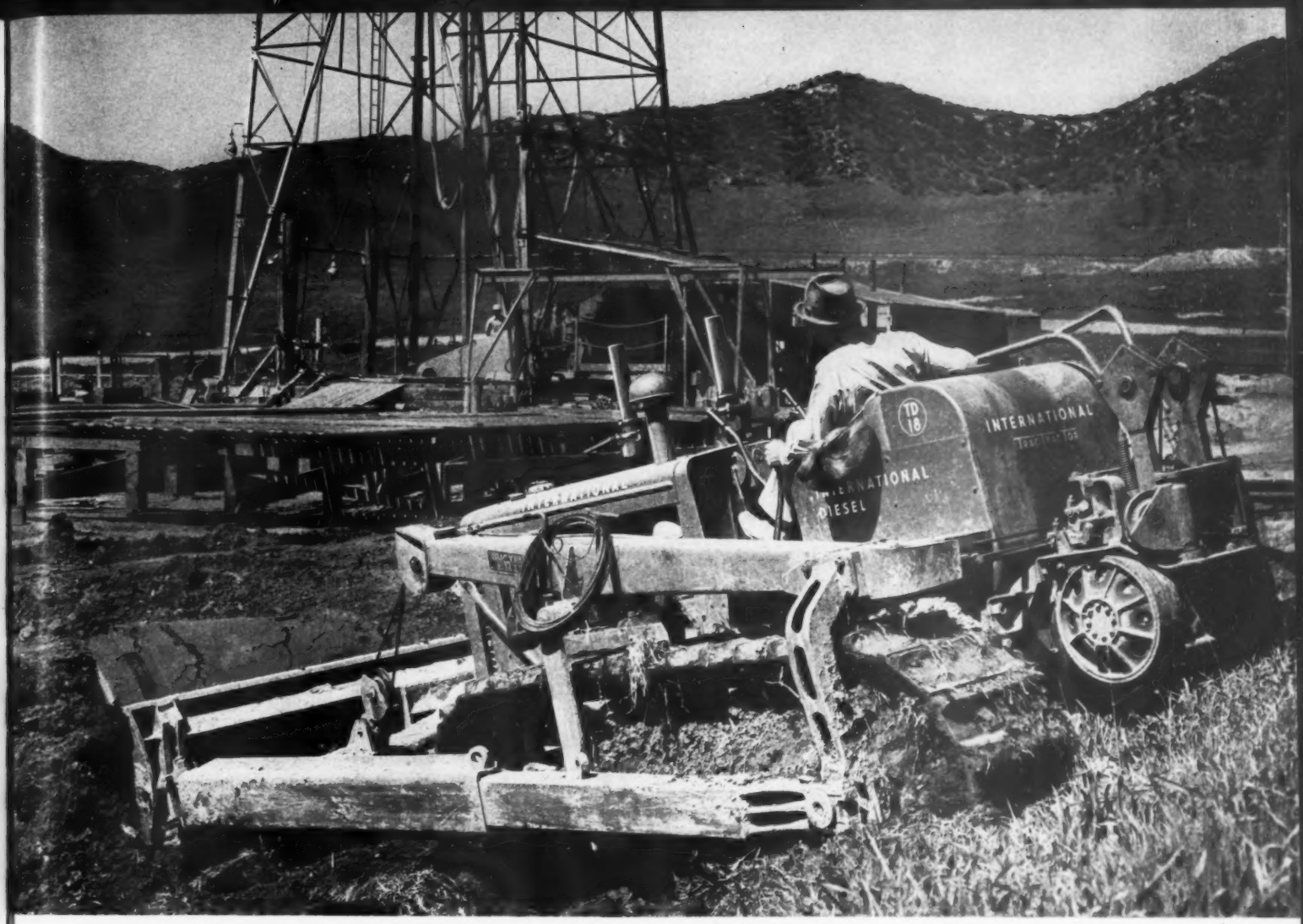

Long life, stamina, and the ability to take terrific punishment are *built right into* all International TracTracTors. This TD-18 Diesel, with cable-operated bullgrader, is working on Barnsdall Oil Co. property at the Newhall-Potrero field in California.

GIVE 'ER THE GUN!

and Watch This International TracTracTor Perform

INTERNATIONAL TracTracTors are setting new performance standards today. They're having to work harder and live longer. There is less time out, more hours of work crowded into busy days. You can "give 'em the gun" and get the job done—on time, and often ahead of schedule.

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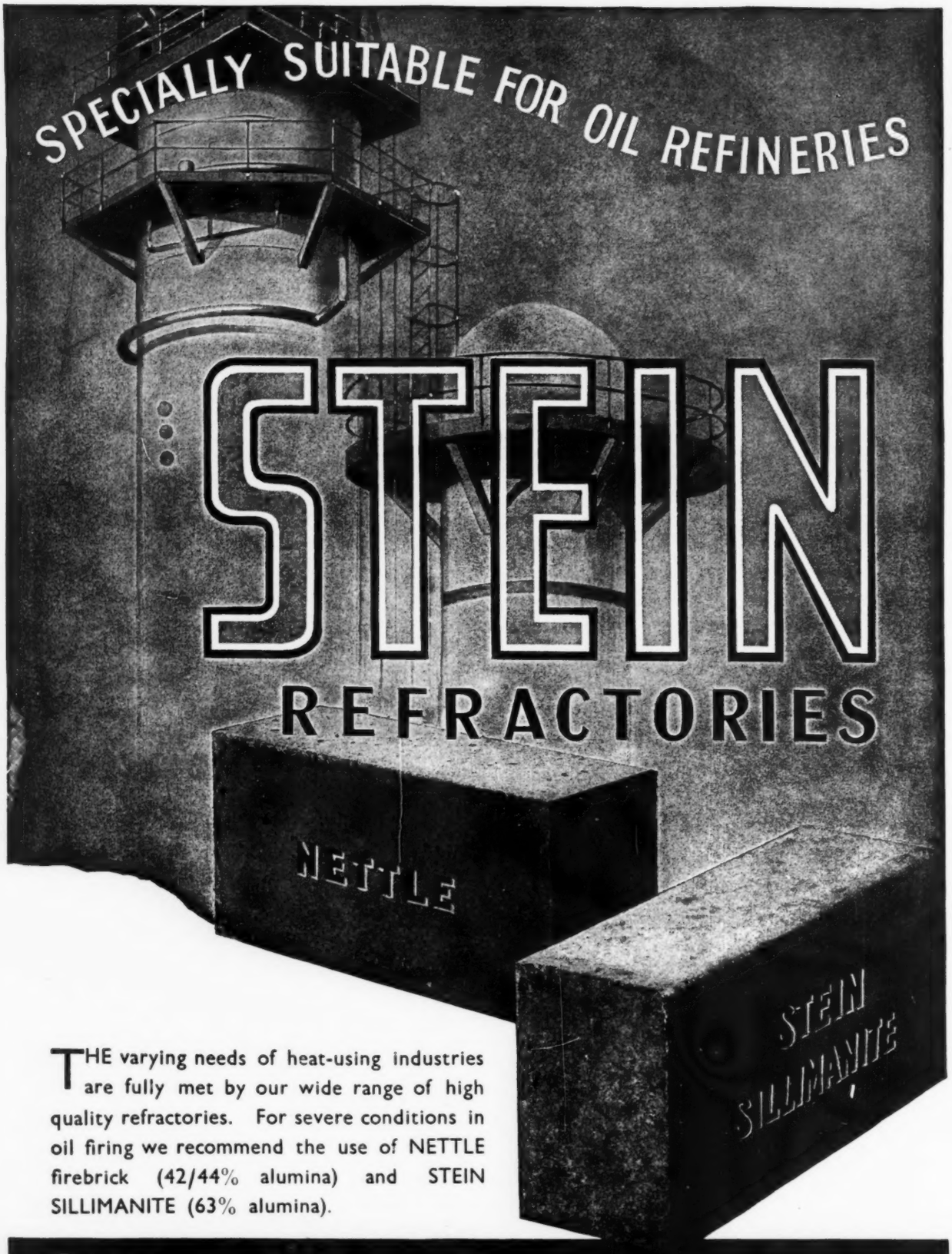

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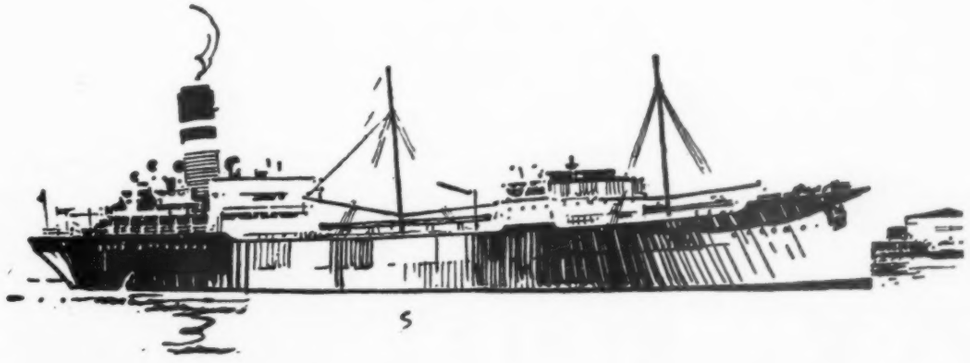

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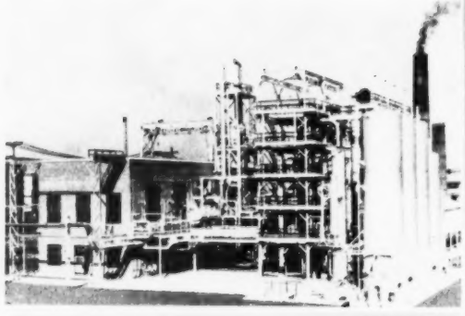

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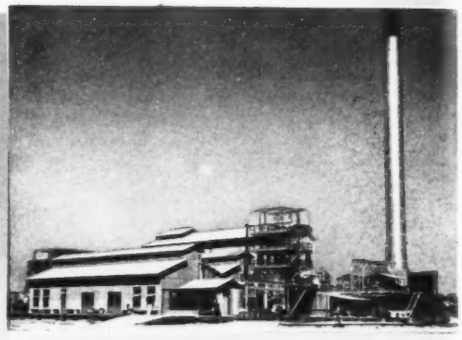

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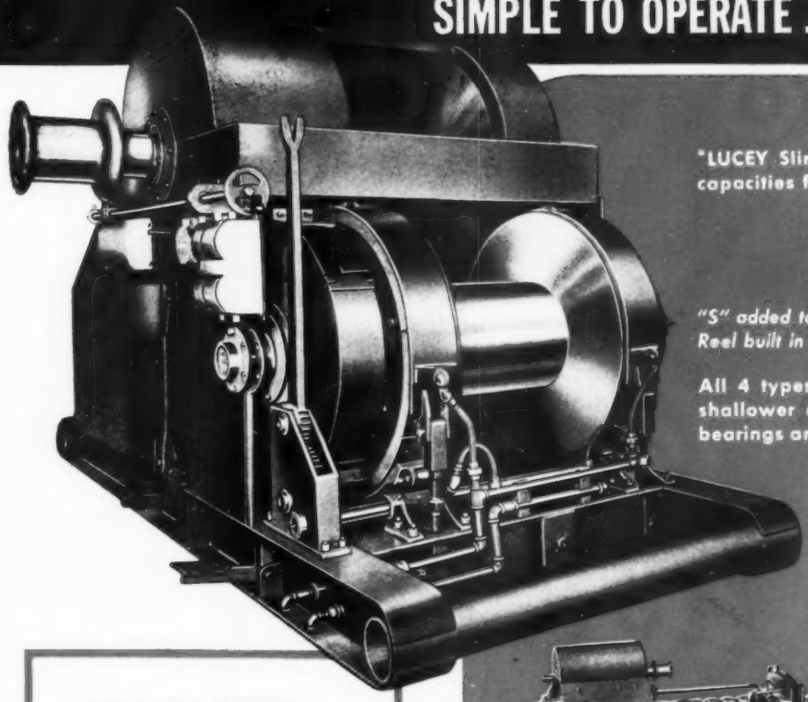


*LUCEY Slim Hole Drilling Outfits are built in 4 sizes and capacities for drilling to the following depths:

Type "B" — 2,000 ft. to 3,000 ft.
Type "C" — 3,000 ft. to 4,000 ft.
Type "D" — 4,000 ft. to 5,000 ft.
Type "E" — 5,000 ft. to 7,000 ft.

"S" added to above types indicates outfit is supplied with Sand Reel built in as part of Drawworks unit. Sand Reel optional.

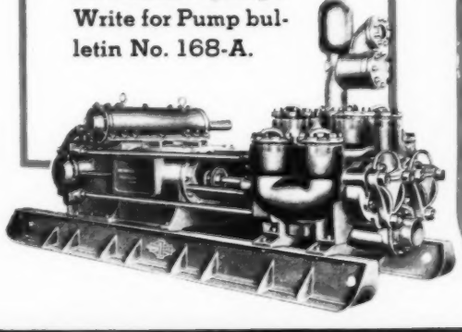
All 4 types are identical in general design. Outfits for shallower depths have fewer Texropes, smaller drums, bearings and other dimensions. Engines of smaller horsepower are used and Slush Pumps are smaller. All Drawworks units are roller bearing throughout, equipped for manual control. They may be arranged for air control if so ordered.

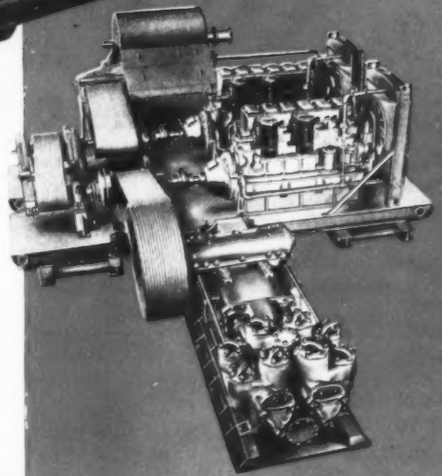
ATTRIDGE REVERSING PULLEY (patented) supplied on all outfits as standard practice unless ordered otherwise. Reversing mechanism is contained inside Texrope sheave and is operated from driller's position in conjunction with the two-engine control.

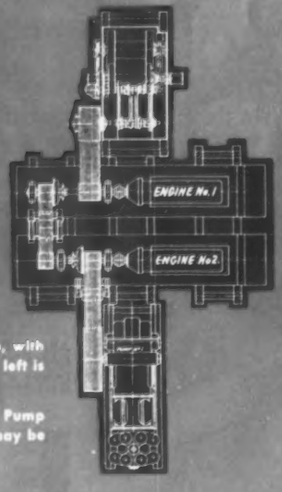
WHELAND-LUCEY POWER SLUSH PUMP

H P-11500-AB-7½" x 14"

This pump is recommended for use with type "E" or "ES" slim hole outfits. The smaller outfits for shallower drilling utilize smaller pumps. Write for Pump bulletin No. 168-A.







General Specifications: The type "ES" outfit is shown above, with the hook-up plan at right. The Drawworks unit shown above left is the "ES" type . . . (with Sand Reel).

Each outfit consists of the Drawworks unit, two Engines and a Pump —all mounted on individual sled-type skids. Two pumps may be supplied if desired.

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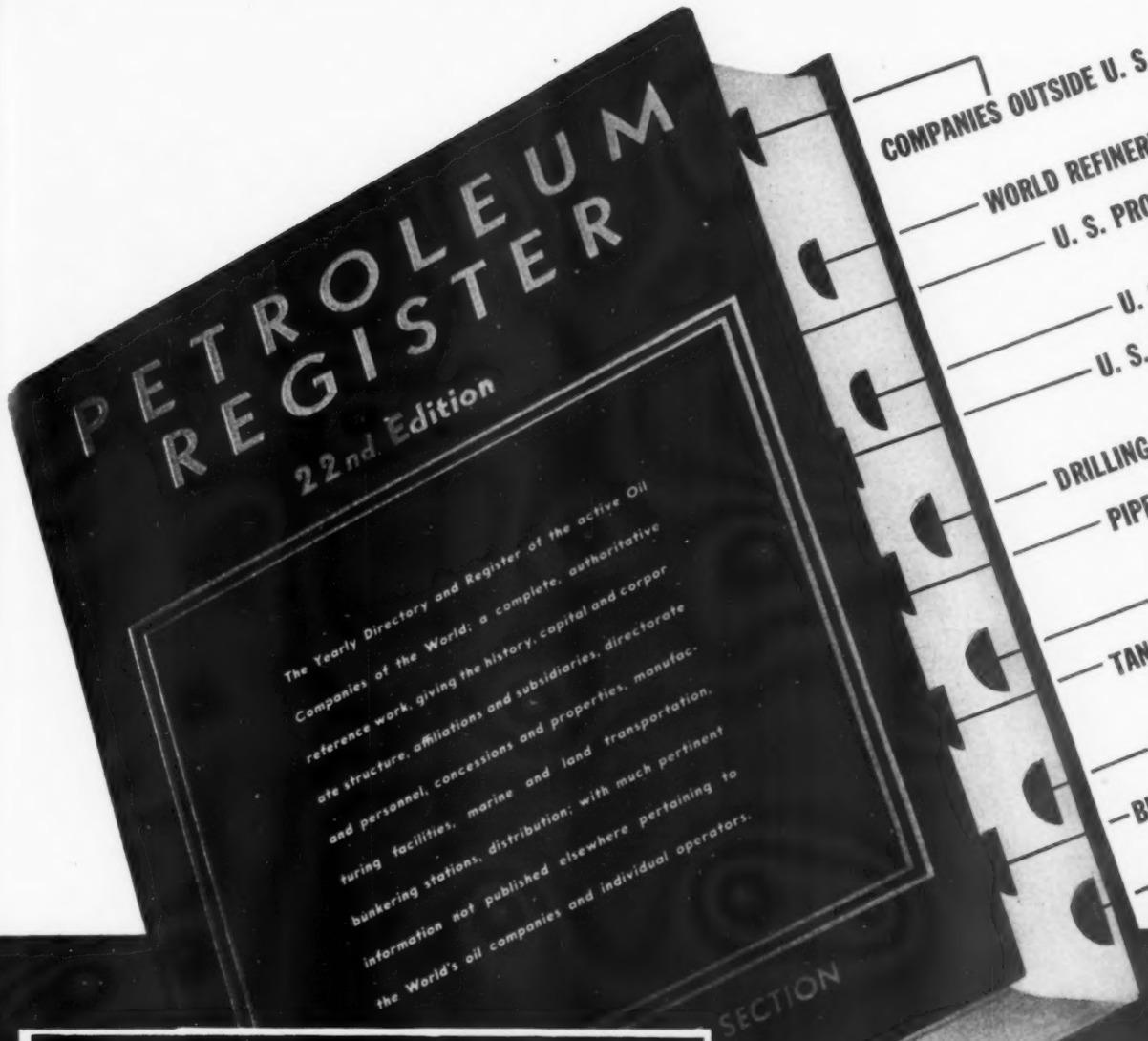
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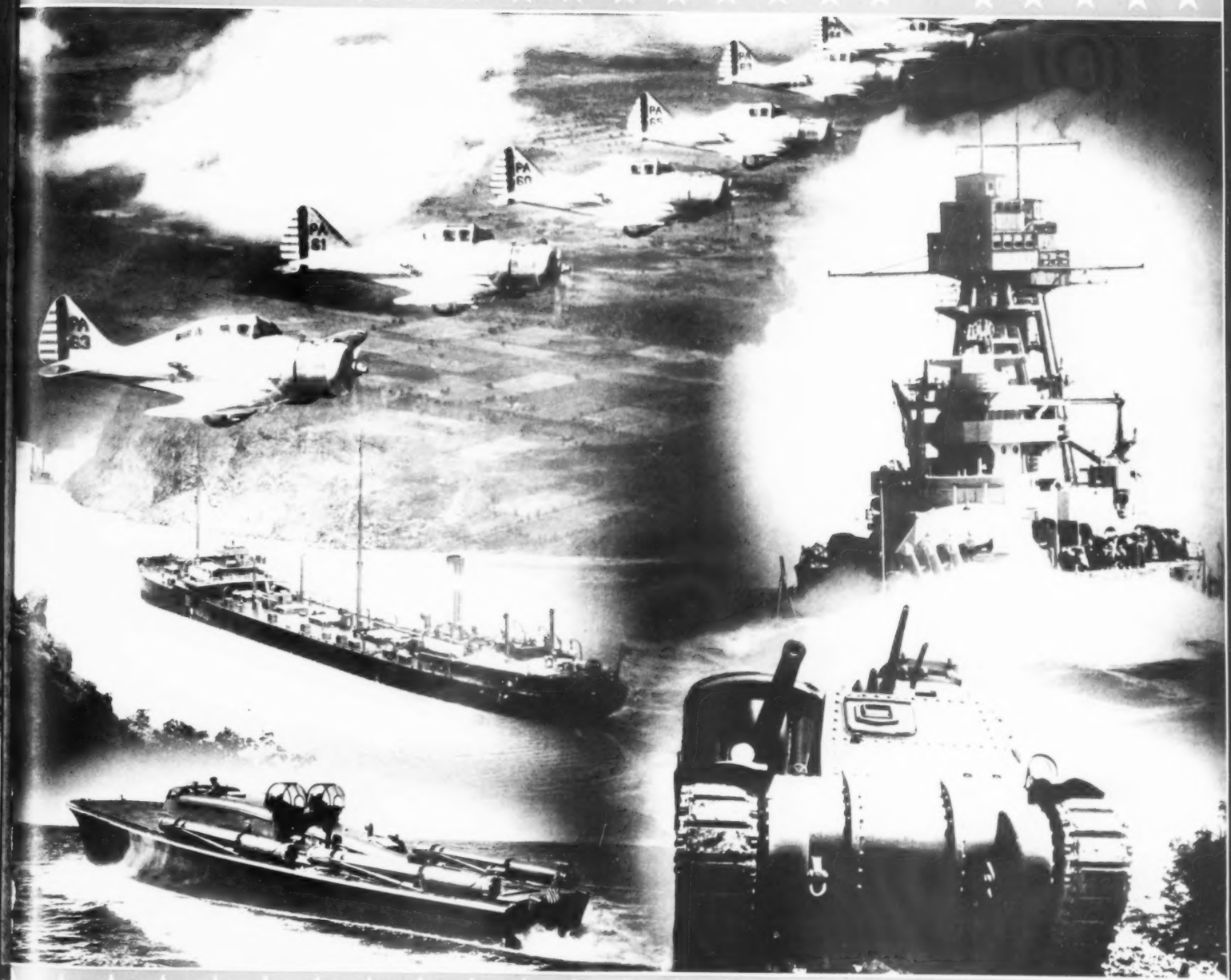

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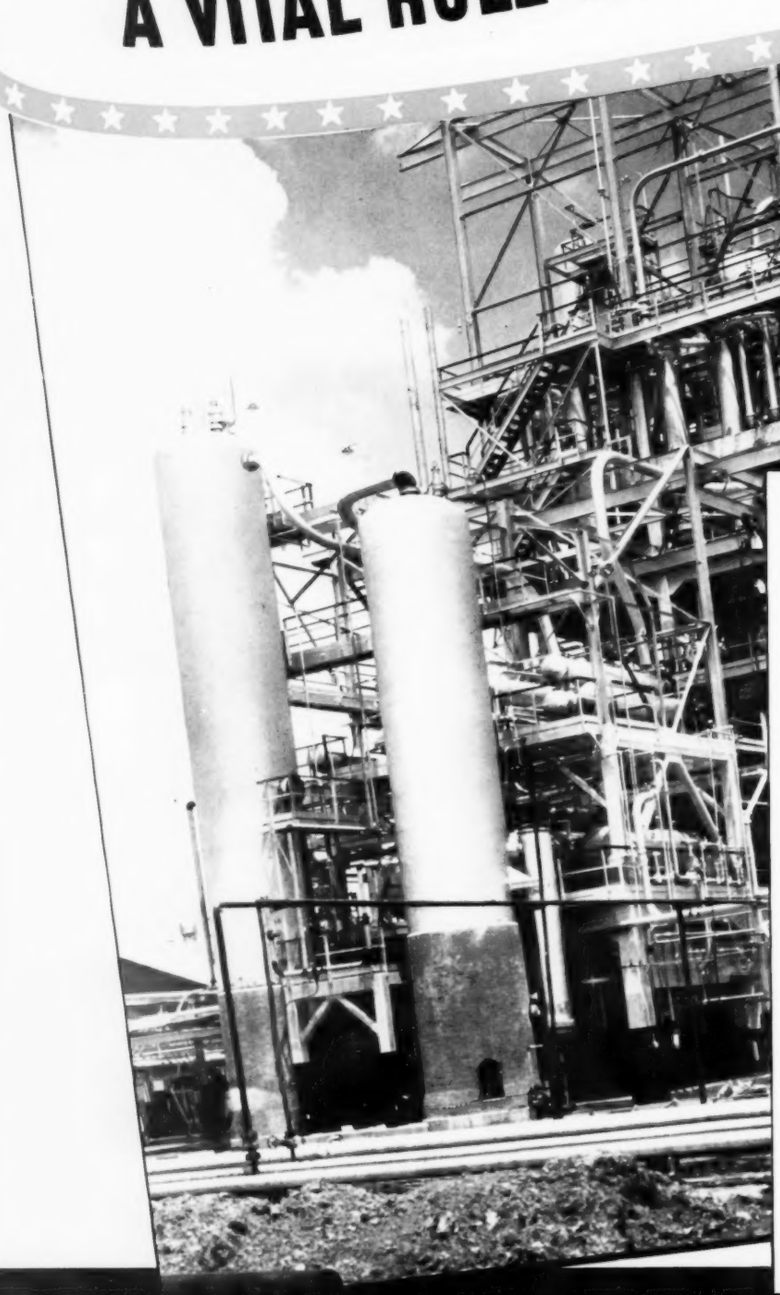
A VITAL ROLE IN NATIONAL DEFENSE



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- Ammonium picrate plant
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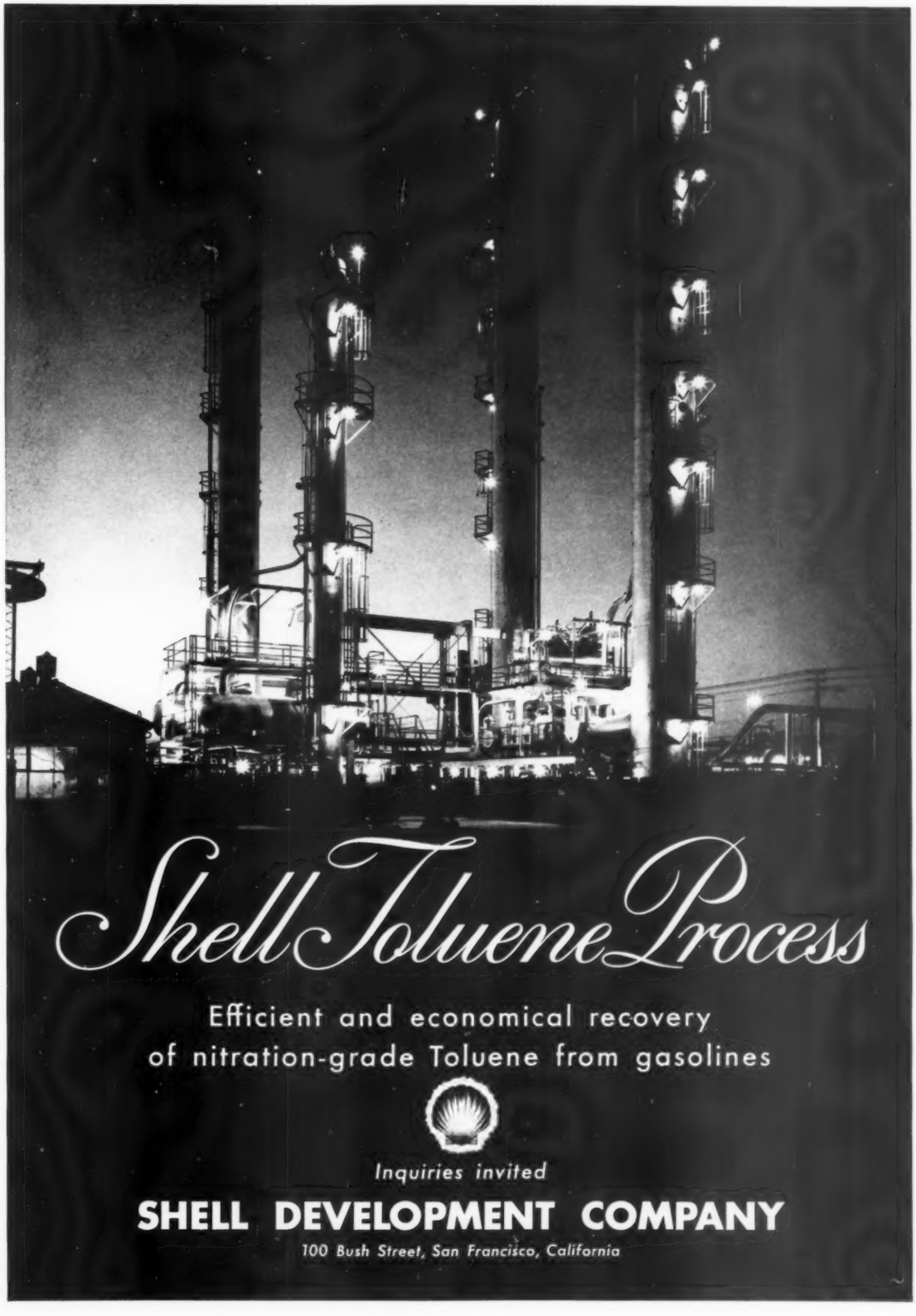
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Faith

OUR FAITH lies in the indomitable nature of Man . . . typified by you and thousands of others in all walks of life who have solved, step by step, the most baffling problems in the world.

WHEN YOU REALIZE that in hardly more than a century Man has harnessed steam, combustible fuels and electricity to do his will . . . that he flies nearly eight miles in the air, travels fathoms under the sea, flings his voice around the world in an instant, predicts to the second, minute and day when an eclipse will occur 20,000 years hence, weighs the very earth on which he stands, turns night into day with a hair-fine filament and freezes by heating . . . then surely your problems of today are within the realm of mastery.

WITH US, AS WITH YOU, it is shortage of manpower and materials that makes the going tough . . . but we are finding answers to problems that at first appeared insurmountable.

SUBSTITUTES may replace some familiar materials out of necessity . . . design changes may result . . . but Progress has not stopped at Kerotest.

KEROTEST VALVES AND FITTINGS, being produced as rapidly as possible, are the result of progressive designing and the well-chosen use of available materials that still maintain the same accuracy, dependability and serviceability you have always known as the hallmark of Kerotest products.

OUR FAITH has proved well-placed in Man . . . who unfailingly accomplishes the seemingly impossible. Our faith is rewarded by the continued, even though somewhat limited, production of top quality Kerotest Valves and Fittings in the face of most adverse supply conditions.

SHARE WITH US a similar faith in dealing with your own problems and look to Kerotest, as always, for the dependability and acknowledged economy of genuine Kerotest Valves and Fittings.

KEROTEST MANUFACTURING COMPANY

PITTSBURGH · PENNSYLVANIA

J. A. Hackett

General Sales Manager

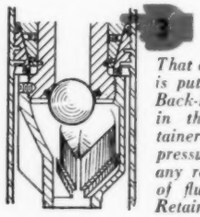
KEROTEST

YOU DON'T HAVE TO KEEP YOUR FINGERS CROSSED When Doing a Squeeze Job with a BAKER CEMENT RETAINER

When you're doing an important squeeze job, it's a mighty good feeling to know that the tool you ran in the hole will do its work and do it properly. That's why superintendents who have the responsibility of seeing that squeeze cement jobs turn out successfully like to run Baker Cement Retainers. When a Baker Cement Retainer is on the job, they are sure of three important things:

1 *That the cement can be put away at the necessary pressures, and the Cement Retainer will remain securely set and packed off.*

2 *That fluid can be bled off (through the Circulation Joint) at any time during circulation or cementing operations.*



3 *That after the cement is put away, the Ball Back-Pressure Valve in the Cement Retainer will hold the pressure and prevent any return movement of fluid through the Retainer.*

NOT AN EXPERIMENTAL TOOL

It is important to realize that the Baker Cement Retainer is in no sense an experimental tool . . . it has been used successfully in thousands of oil wells in fields throughout the world. The original Baker Cement Retainer was invented (and the name "Cement Retainer" originally coined) some 30 years ago, and the present tool embodies the knowledge and experience gained during that time in both manufacturing and running many Cement Retainers.

It is in this accumulation of skill and experience that goes with every Baker Cement Retainer run into the hole today, and is the reason why . . . *you don't have to keep your fingers crossed when a Baker Cement Retainer is doing your squeeze job.*

BAKER OIL TOOLS, INC.

Main Office and Factory: 6000 So. Boyle Avenue
P. O. Box 127, Vernon Station, Los Angeles, California
Central Division Office and Factory: 6023 Navigation Boulevard
P. O. Box 3048, Houston, Texas
Export Sales Office: 19 Rector Street, New York, N. Y.

IMPORTANT CEMENT RETAINER APPLICATIONS:

Re-Cementing • Cementing Behind Sections of Pipe • Reducing Gas/Oil Ratios • Series Cementing Plugging off Bottom Fluids • Plugging Back to Upper Zones • Testing Upper Cased Formations Squeeze Jobs • As a Heaving Plug • As a Bridge Plug at any Place in Casing or Liner

BAKER CEMENT RETAINER